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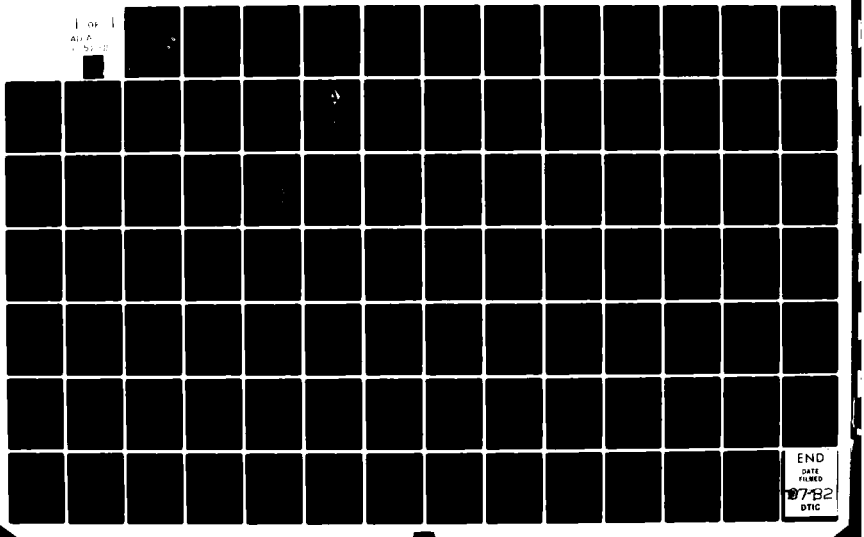

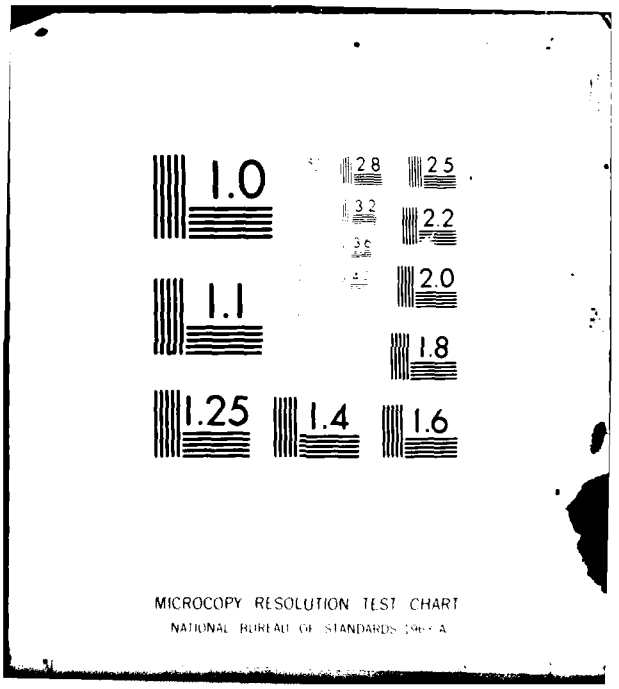
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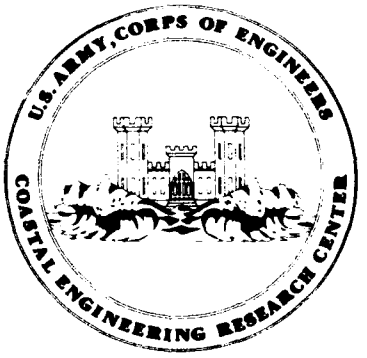
Long-Term Effects of Beach Nourishment on the Benthic Fauna of Panama City Beach, Florida

by

J.K. Culter and S. Mahadevan

MISCELLANEOUS REPORT NO. 82-2

JANUARY 1982



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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: MR 82-2	2. GOVT ACCESSION NO.: AD-A115212
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): LONG-TERM EFFECTS OF BEACH NOURISHMENT ON THE BENTHIC FAUNA OF PANAMA CITY BEACH, FLORIDA	5. TYPE OF REPORT & PERIOD COVERED: Miscellaneous Report
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): J.K. Culter and S. Mahadevan	8. CONTRACT OR GRANT NUMBER(s): DACW72-79-C-0026
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Mote Marine Laboratory, 1600 City Island Park, Sarasota, Florida 33577	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: G31266
11. CONTROLLING OFFICE NAME AND ADDRESS: Department of the Army, Coastal Engineering Research Center (CERRE-CE), Kingman Building, Fort Belvoir, Virginia 22060	12. REPORT DATE: January 1982
	13. NUMBER OF PAGES: 94
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Beach nourishment effects
Benthic fauna
Panama City Beach, Florida
Surface sediments

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The long-term effects of beach nourishment on the benthic infauna and surface sediments of Panama City beaches were investigated. Forty-seven stations located on nine transects between West Pass and Philips Inlet, and two nourishment borrow sites were sampled in November-December 1979 and May 1980. The data collected were compared to prenourishment base-line information collected by Saloman (1976).

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cont

Abiotic parameters, water temperature, dissolved oxygen and salinity were measured. Sediments were analyzed for particle-size distribution, percent organic carbon and percent carbonate.

Benthic macroinvertebrates were represented by 162 taxa of 14 major animal phyla. Species composition and faunal densities varied seasonally. Polychaetes and amphipods were the most abundant animal groups; a small number of species were dominant at nearly all stations. Species diversity was lowest in the swash zone and sandbar stations and highest offshore.

Sediment composition was similar to that of Saloman's (1976) study within limits of sampling and processing errors. Faunal composition was found to be different from 1976 but was attributed to normal seasonal and spatial variations. Based on benthic community analyses and sediment parameters, no significant differences were found between nourishment borrow sites and surrounding areas and in the nearshore areas where beach nourishment was conducted. No long-term adverse effects of beach nourishment were detected.

PREFACE

This report is published to provide coastal engineers the results of an investigation on the long-term effects of beach nourishment on the benthic infauna and surface sediments of Panama City Beach, Florida. The work was carried out under the coastal ecology research program of the U.S. Army Coastal Engineering Research Center (CERC).

The report was prepared by J.K. Culter and S. Mahadevan, Mote Marine Laboratory, Sarasota, Florida, under CERC Contract No. DACW72-79-C-0026. Participants during the investigation included K. Caraccia, F. Dalton, J. Drake, L. Eaton, L. Ferris, M. Gallo, G. McCallum, J. McIntosh, M. Messick, K. Moller, A. Rule, T. Russell, N. Stout, J. Weber, and R. Yarbrough.

The authors gratefully acknowledge the following scientists who helped during various aspects of this study: E. Nakumura, Director of the National Marine Fisheries Service, Gulf Fisheries Center, Panama City Laboratory, and the laboratory staff for their logistical aid during the fieldwork of this study; C.H. Saloman, also of the National Marine Fisheries Service, for his comments and assistance during the initial site survey; and Dr. W.H. Taft for suggestions concerning the sedimentology parts of the study. Assistance in the identification and verification of the various animal taxa collected was provided by Drs. R.T. Abbott (mollusca), E.D. Estevez (isopoda), R.W. Heard, Jr. (amphipoda, decapoda, and carideans), W. Price (cumacea), and C. Hunter (sipuncula).

E.J. Pullen, Chief, Coastal Ecology Branch, was the CERC contract monitor for the report, under the general supervision of R.P. Savage, Chief, Research Division.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

LONG-TERM EFFECTS OF BEACH NOURISHMENT ON THE BENTHIC FAUNA OF PANAMA CITY BEACH, FLORIDA

by
J.K. Culter and S. Mahadevan

I. INTRODUCTION

1. Background Information.

Coastal erosion is a major problem on many U.S. coastlines including the west coast of Florida. The westernmost beaches of Bay County on the Florida panhandle are considered critical areas of erosion (U.S. Army Engineer Division, South Atlantic, 1971; Bruno, 1971). Before the initiation of a nourishment program in 1976, the shoreline west of the entrance to St. Andrew Bay suffered considerable erosion for a number of years, causing many coastal structures to become vulnerable to storm damage. On 23 September 1975 Hurricane Eloise caused additional erosion and destroyed or undermined the foundations of numerous coastal structures (Saloman, 1976). Extensive areas of the Panama City and neighboring beaches were renourished in 1976 by hydraulically dredging offshore sands to replace the eroded beaches; however, observations made during this study inidicate that the bulk of the material deposited during the nourishment program has since eroded to prenourishment levels.

This study, which CERC contracted to the Mote Marine Laboratory, evaluates the long-term nourishment effects on the benthic fauna and surface sediments of the nearshore zone off Panama City Beach, Florida. The results of the study (1979-80) are compared to those obtained in the prenourishment study (1974-75) and in the study of short-term effects (1976-77) of the same beach (Saloman, 1976; Saloman, Naughton, and Taylor, in preparation, 1982).

Saloman's prenourishment study (1974-75) describes the area as having a diverse benthic macroinfauna with the number of species and faunal densities fluctuating seasonally. Species of polychaetes and amphipods dominated the fauna. The distribution of species was generally uniform along the beach with the number of species increasing offshore. There was no correlation of animal abundance to selected sedimentological parameters, which showed little spatial variation.

The short-term study of nourishment effects (Saloman, Naughton, and Taylor, in preparation, 1982) concluded that an initial destruction of the bottom community at the borrow pits was followed by rapid recovery virtually complete after 1 year. Minor differences in sediment parameters could be detected at the borrow pits after 1 year, but no distinction could be made between the faunas in and outside the borrow pits. The authors also concluded that normal seasonal variations of temperature and salinity could mediate changes in benthic diversity and abundance possibly masking or preventing detection of nourishment effects.

2. Study Area.

The study area, located on the northeastern shore of the Gulf of Mexico at Panama City, Florida, is bounded by the entrance to St. Andrew Bay (West Pass) and Philips Inlet, 34.3 kilometers to the west (Fig. 1). The easternmost part of the study area remains in a natural state (St. Andrews State Park) with extensive dunes backing the beach; the remainder of the area has been extensively developed with motels, condominiums, and support facilities occupying most of the beach front.

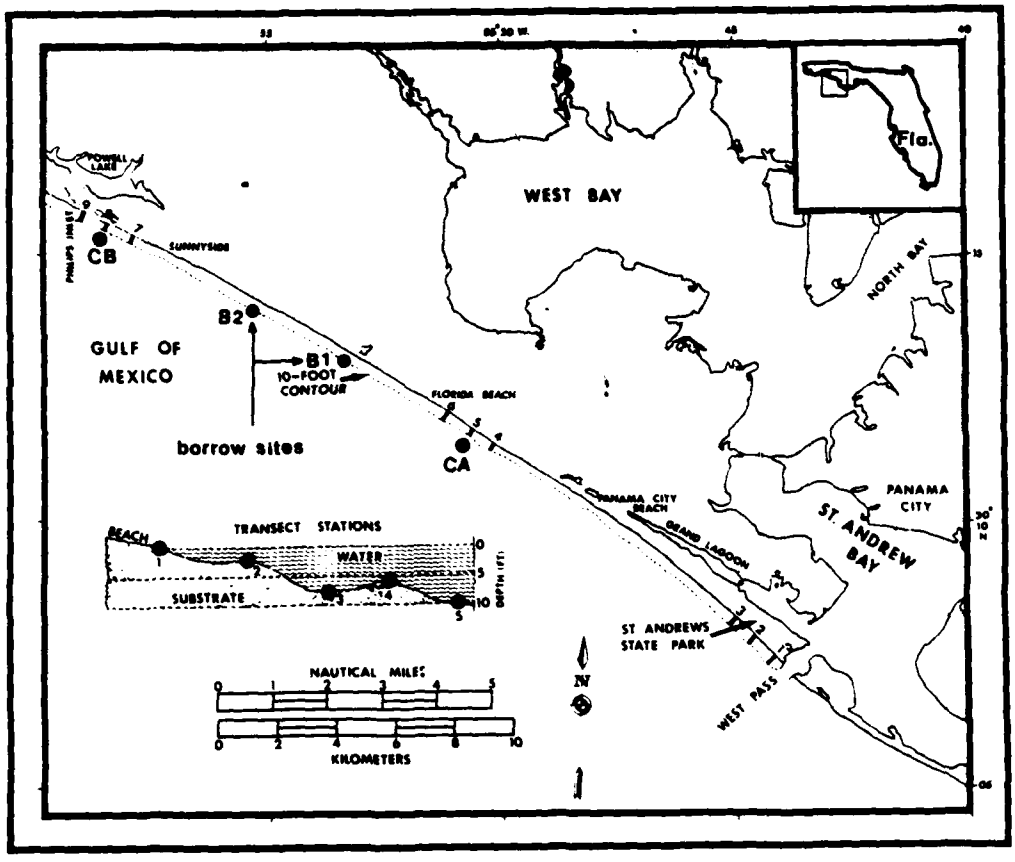

Figure 1. Study area, depicting transect and station locations in the Gulf of Mexico between West Pass and Philips Inlet.

The beaches along this part of the Gulf of Mexico have moderate wave energy with intensity increasing from east to west (Price, 1954; Tanner, 1960). The shoreline is fronted by two prominent offshore sandbars. The inner bar lies 23 to 91 meters offshore and is often sinuous and broken. The second bar, about 244 meters offshore, is continuous and uninterrupted. The depth of the first bar is generally less than 1.5 meters; the depth of the second bar is 3 to 4 meters. Just beyond the second bar the bottom slopes rapidly to about 9 to 10 meters. This slope continues to about 18 meters and then becomes more gradual. The continental shelf in this area is not nearly as wide as it is in most areas of the Gulf of Mexico.

The segment of gulf shoreline from Destin East Pass to St. Andrew Bay is unusual because it lacks the coastal barrier islands typical of Florida coastal geography (Bruun, Gerritsen, and Morgan, 1958). Kwon (1969) describes the physiography of the area as an erosional feature of the gulf coast. Prevailing winds in the area are from the southeast to south, generating an east-to-west longshore current. Balsillie (1975) summarized estimates of longshore transport for the beaches of the Florida panhandle. In the vicinity of St. Andrews Park the net longshore transport rates are estimated to range from 56,377 to 173,554 cubic meters per year.

3. Study Objectives.

This study provides information on the ecological relationship of the benthic fauna inhabiting natural beaches and offshore borrow areas. Infaunal community structure and surface sediment characteristics were examined following a beach nourishment program on the Panama City and nearby beaches. The data collected were compared with prenourishment base-line data to determine long-term effects of beach nourishment on benthic infauna. Specific objectives of the study were to

(a) quantitatively sample the benthic macroinfauna at 49 nearshore stations, including two borrow sites;

(b) identify the organisms collected to the lowest practical taxonomic unit;

(c) define the distribution, density, diversity, and other community parameters of the nearshore benthic infauna;

(d) collect surface sediment samples at each station and evaluate the granulometric composition as well as the organic carbonate content;

(e) sample during winter and summer months to determine seasonal variations; and

(f) compare the data collected with Saloman's (1976) data and evaluate the results in terms of beach nourishment effects.

4. Station Locations.

A total of 49 stations were sampled during this study. Forty-seven stations, located on nine transects in the Gulf of Mexico between West Pass and Philips Inlet, are the same as those sampled by Saloman (1976). The transects were positioned perpendicular to shore and each contained five stations (Fig. 1): station 1 in the swash zone; station 2 on the first sandbar; station 3 between the first and second sandbar; station 4 on the second sandbar; and station 5 seaward of the second sandbar in 3 to 4 meters of water. Stations CA and CB (control sites) were located in 9 to 10 meters of water off transects 5 and 8.

Locations of the nine transects along Panama City Beach are as follows: transect 1 is 274.3 meters west of the jetty at the entrance of St. Andrew

Bay in St. Andrews State Park; transect 2 is 30.5 meters east of the pier in St. Andrews State Park; transect 3 is offshore of the intersection of Lookout Street and Spyglass Street; transect 4 is offshore of the Holiday Inn West; transect 5 is offshore of the Fiesta Motel; transect 6 is offshore of the Fountainbleau Terrace Motel; transect 7 is offshore of the Sunnyside Motel; transect 8 is offshore of the Roundtower Motel; and transect 9 is offshore of Pinnacle Port. The motel names for transects 4 and 6 were reversed in Saloman (1976).

In addition to the 47 stations, 2 borrow sites that were dredged in July and August 1976, but have since filled in, were also sampled. Borrow site B1 is located about 6.4 kilometers southeast of Laguna Beach, offshore of the Ambassador Motel, 183 meters from Highway 98 in about 6.1 meters of water. The site is rectangular, 152 by 23 meters, and parallel to the beach. Borrow site B2 is located about 2.4 kilometers southeast of Laguna Beach in front of the Peppertree Motel (abandoned), 274 meters offshore of Highway 98 in about 6.1 meters of water. The site is rectangular, 229 by 128 meters, and is oriented diagonally to the shoreline. Stations CA and CB served as control stations for the borrow sites.

II. MATERIALS AND METHODS

1. Physical Parameters.

Temperature (in ^{o} Celsius), dissolved oxygen (in parts per million), and conductivity (in micromhos per centimeter) were measured at each station with a Hydrolab *in situ* physicochemical monitor. Where water depth was sufficient, readings were taken 0.5 meter below the surface as well as 0.5 meter above the bottom. Logbook entries for conductivity were corrected for temperature and converted to salinity (in parts per thousand). Dissolved oxygen readings were corrected for salinity.

2. Topography.

Using standard surveying techniques, beach profiles were constructed for each of the nine transect sites. Beginning landward at the surveying monuments, the profiles extended seaward to wading depth.

3. Sediment Characteristics.

At each station two sediment samples were taken with a 5.08-centimeter-diameter polyvinylchloride (PVC) core. The cores were inserted 10 to 15 centimeters into the substratum, removed and both ends corked. The samples were then transferred to 454-milliliter plastic jars with internal and external labels, frozen, and stored until analyzed. One sample from each station was processed for grain size, organic content, and carbonate content. The second sample served as a backup.

Laboratory analysis of sediment samples is schematically shown in Figure 2. Details of the procedures are as follows:

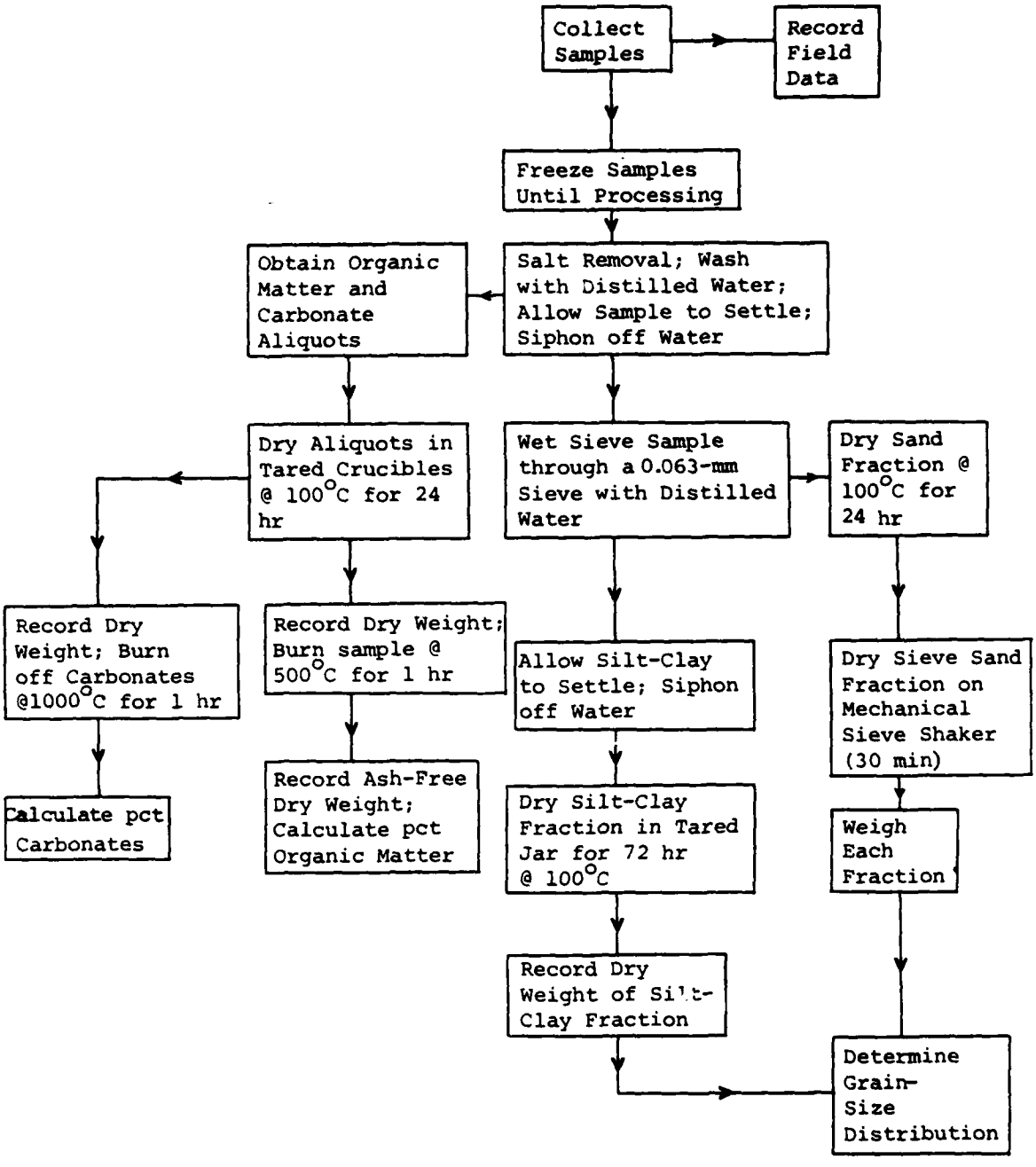

Figure 2. Schematic of sediment analysis procedures.

(a) Grain-size analysis was performed by sieving a dried sample aliquot through a series of 20-centimeter-diameter nested sieves of 1-phi mesh intervals (Wentworth scale) for 30 minutes. The sample was first rinsed with distilled water to remove salt and sieved wet with a 0.063-millimeter mesh to remove any silt-clay fractions (also dried and weighed).

(b) Organic carbon present in each sample was determined by combusting a previously dried sample at 500° Celsius for 1 hour. The loss due to ignition was considered to be the organic carbon content.

(c) Carbon as present in carbonate compounds was determined by heating a sample (organic carbon previously burned off) to 1000° Celsius for 1 hour. The weight loss was considered to be the amount of carbon, as carbonates, present in the sample.

Various data analysis procedures were used in the statistical analyses (Tables 1 to 4) of the sediment samples. Organic carbon and carbonate values were calculated and presented as percentages of the total sample. Statistics on the grain-size distribution were performed using the following formulas, where phi ($\emptyset$) = $-\log_2 x$; x = particle size in millimeters:

(a) Median grain size, Md, is the point at which half of the particles by weight are coarser and half are finer. It is the diameter corresponding to the 50 percent mark on the cumulative curve.

(b) Mean grain size, Mz, is the overall size measure (Folk, 1974).

$$Mz = \frac{\emptyset 16 + \emptyset 50 + \emptyset 85}{3}$$

(c) Inclusive graphic standard deviation (sorting coefficient), σ, is the measure of uniformity or sorting (Folk, 1974).

$$\sigma = \frac{\emptyset 84 - \emptyset 16}{4} + \frac{\emptyset 95 - \emptyset 5}{6.6}$$

(d) Inclusive graphic skewness, Sk, measures the degree of asymmetry of the particle distribution curve, taking into account the skewness of the tails of the curve as well as the central part. It is independent of the sorting of the sample. A symmetrical curve has a skewness of zero; a positively skewed curve indicates an excess of fine material; a negatively skewed curve indicates an excess of coarse sediments (Table 3) (Folk, 1974).

$$Sk = \frac{\emptyset 16 + \emptyset 84 - 2\emptyset 50}{2\ (\emptyset 84 - \emptyset 16)} + \frac{\emptyset 5 + \emptyset 95 - 2\emptyset 50}{2\ (\emptyset 95 - \emptyset 5)}$$

(e) Graphic kurtosis, Kg, is the ratio between the sorting in the tails of the granulometric curve and the sorting of the new central part of the curve (Folk, 1974).

$$Kg = \frac{\emptyset 95 - \emptyset 5}{2.44\ (\emptyset 75 - \emptyset 25)}$$

Table 1. Sediment classification by particle size (Wentworth classification).

Class	Grain size	
	Phi	Millimeters
Gravel	<-1	>2.0
Very coarse sand	0	>1.0 ≤2.0
Coarse sand	1	>0.5 ≤1.0
Medium sand	2	>0.25 ≤0.5
Fine sand	3	>0.125 ≤0.25
Very fine sand	4	>0.0625 ≤0.125
Silt clay	> 4	≤0.0625

Table 2. Degree of sediment sorting based on inclusive graphic standard deviation (Folk, 1974).

Standard deviation	Degree of sorting
<0.35 Ø	Very well sorted
0.35 Ø - 0.50 Ø	Well sorted
0.50 Ø - 0.71 Ø	Moderately well sorted
0.71 Ø - 1.00 Ø	Moderately sorted
1.00 Ø - 2.00 Ø	Poorly sorted
2.00 Ø - 4.00 Ø	Very poorly sorted

Table 3. Classification of sediment by skewness (Folk, 1974).

Sk values	Degree of skewness
+1.00 - +0.30	Strongly fine-skewed
+0.30 - +0.10	Fine-skewed
+0.10 - -0.10	Near symmetrical
-0.10 - -0.30	Coarse skewed
-0.30 - -1.00	Strongly coarse-skewed

Table 4. Classification of sediment by kurtosis (Folk, 1974).

Kg values	Degree of kurtosis
<0.67	Very platykurtic
0.67 - 0.90	Platykurtic
0.90 - 1.11	Mesokurtic
1.11 - 1.50	Leptokurtic
1.50 - 3.00	Very leptokurtic
>3.00	Extremely leptokurtic

4. Benthic Fauna.

a. Field Procedures. Benthic fauna was sampled with a stainless-steel plug sampler (Fig. 3) covering a surface area of 0.016 square meter and penetrating to a depth of 23 centimeters. This was the same type coring device used by Saloman (1976). The top of the core was covered with 0.5-square millimeter mesh, stainless-steel screen to prevent loss of organisms. In operation the sampler is inserted into the substratum; the sediments on the outside of one side of the sampler are removed, and the sampler tilted and lifted out with a hand covering the bottom. At stations with a water depth greater than 1.2 meters the sampler is operated by a diver who removes the core, inverts it, and places it in a metal basket. When four cores are obtained, the basket is hauled to the surface vessel, where the samples are extruded into labeled 5-gallon (19 liters) plastic buckets. Samples taken in less than 1.2-meter depths are obtained by wading and returning to the beach for processing.

Five plug samplers were taken at each station: four samples for faunal analysis and one as a backup in case of a loss of a processed sample. Onshore the samples were washed through a box sieve with a mesh of 0.701 square millimeter. The material retained on the sieve was placed in a plastic jar with both internal and external labels. A 10 to 15 percent solution of magnesium chloride in seawater was added to the jars to relax the organisms in order to reduce fragmentation upon preservation. After relaxation, a 10 percent formalin-seawater buffered solution containing rose bengal stain (to facilitate sorting) was added to the samples. Samples were transferred to 70 percent isopropyl alcohol within a week of initial preservation.

b. Laboratory Procedures. In the laboratory faunal samples were sorted under a stereozoom binocular dissecting microscope. Taxonomic identifications were performed under the binocular dissecting scope or a binocular compound microscope. Identifications of species were accomplished with the use of descriptive literature and a set of reference specimens from Saloman (1976). Additionally, taxonomic experts were utilized to either identify or confirm identifications of selected taxa.

c. Data Analysis Procedures. Numerical indices were chosen which have a widespread use in scientific literature and provide summaries of data, and which would aid comparisons with Saloman's (1976) data.

Faunal density estimates are reported as numbers of individuals per square meter. Values were computed by dividing the total number of individuals found at a station (for four replicates) by the total area sampled (0.0624 square meter).

Species richness was considered to be the total number of species found at each station for all replicates.

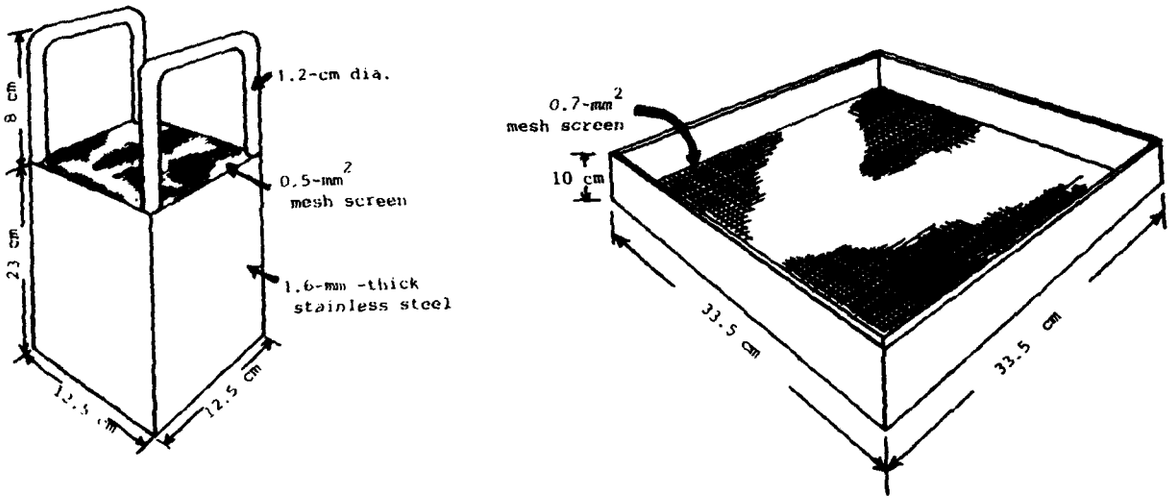

Figure 3. Sieve and plug sampler used for quantitative benthic studies.

Menzies, George, and Rowe (1973) define species diversity as a concept in community ecology which refers to the heterogeneity (or lack of it) in a community or assemblage of organisms. Thus, diversity is dependent upon the number of species present (species richness, S) and the distribution of individuals among species (equitability or evenness). Another definition of diversity is simply the number of species found in a unit area (Whittaker, 1972). Indices to measure diversity, species richness and equitability are so numerous that confusion exists (e.g., Hairston, 1964; Sanders, 1968; Hurlbert, 1971; Whittaker, 1972; Fager, 1972; Peet, 1974; Pielou, 1975; Smith, et al., 1979). The proliferation of indices prompted Hurlbert (1971) and Peet (1974) to recommend discarding diversity as a measure in ecological studies. However, placed in the proper perspective, diversity indices have been shown to be useful in "bioenvironmental" studies (Boesch, 1972; Borowitzka, 1972; Swartz, 1972; Pearson, 1975; Swartz, 1978). In this study the data analysis is restricted to the two commonly used diversity indices: the Shannon-Weaver index (Shannon and Weaver, 1963) and the Gini's index (Gini, 1912; Simpson, 1949).

(1) The Shannon-Weaver Index of Diversity. This index is based on information techniques, where diversity is equated to the amount of uncertainty which exists regarding the species identity of an individual selected at random from a community. The more species and the more evenly their representation, the greater the uncertainty and hence, the greater the diversity. The computational formula for Shannon's index is

$$H' = C/N \left(N \log_{10} N - \sum_{i=1}^{s} n_i \log_{10} n_i\right)$$

where C = 2.3026 (for "nats", units expressed as natural logarithms), N is the total number of individuals, and n_i the number of individuals in the ith species. Lloyd, et al. (1968) presented the functions of "$n\log_{10}n$" for all integers from n = 1 to n = 1050 to simplify the use of Shannon's index.

(2) Gini's Index of Diversity. This index is a measure of the dominance in a sample. Though it is usually insensitive to rare species, it has been used commonly as a diversity index. The computational formula for dominance diversity (Simpson, 1949) is

$$DM = \sum_{i=1}^{s} n\,(n-1)/N(N-1)$$

and complemental or actual diversity, d = 1 - DM (Gini, 1912).

(a) Equitability. Equitability is considered a component of diversity in that it provides an idea about the evenness of species distribution at a site. Usually, a positive correlation exists between diversity and equitability (De Jong, 1975), i.e., a high equitability would indicate a high diversity. Traditionally, high equitability and diversity have been considered to indicate a "healthy condition" of the fauna. Reduction of equitability usually occurs with an increase in oligomixity (i.e., dominance by few species). Pielou's (1966) method of measuring equitability was used in this study. The computational formula is

$$J' = H'/\log_e s$$

(b) Faunal Similarity. A number of coefficients for measuring faunal similarities are available (Sanders, 1960; Horn, 1966; Whittaker, 1967; Lie and Kelly, 1970; Bray and Curtis, 1975; Grassle and Smith, 1976). However, most of the available coefficients consider only the number and rank of common species and not the distribution of individuals. The Morisita's index (Morisita, 1959), which takes into consideration both the number of species in common and the number of individuals shared, is utilized in this study. Many authors in the past have used this index with a greater degree of success than other overlap coefficients (Ono, 1961; Barnard, 1970; Mauchline, 1972; Bloom et al., 1972; Gage and Geekie, 1973; Menzies, 1973; Paul, 1973; Farrell, 1974; Marum, 1974; Gage, 1975; Mahadevan, 1979). The computational formula for the Morisita's index is

$$C\lambda = 2 \sum_{i=1}^{s} n_{1i}\, n_{2i} / (\lambda_1 + \lambda_2)\, N_1\, N_2$$

where

$$\lambda_1 = \sum_{i=1}^{s} \frac{n_{1i}\,(n_{1i}-1)}{N_1\,(N_1-1)}$$

and

$$\lambda_2 = \sum_{i=1}^{s} \frac{n_{2i}\,(n_{2i}-1)}{N_2\,(N_2-1)}$$

where N_1 and N_2 are the total number of individuals in sample one and two, respectively. n_{1i} and n_{2i} are the number of individuals in the ith species of sample one and two, respectively. The value of $C\lambda$ is about one when the two samples are identical and zero when no common species are present. The index is relatively free from sample size effects.

Faunal similarity comparisons were conducted between Saloman's (1976) collections and this study's collections. Each station was considered as a composite over nine transects.

III. RESULTS

1. Physical Parameters.

a. Present Study. Values for water temperature, salinity, and dissolved oxygen concentration for each station are presented in Table 5, for November-December 1979, and in Table 6 for May 1980. Temperatures during the November-December sampling ranged from 16.5° to 21.0° Celsius. The lower temperatures were usually recorded in the colder, early morning hours before the water became mixed and warmed by solar radiation. Bottom temperatures at the deeper stations were generally slightly warmer than surface temperatures. Variation of temperature was less during May with values ranging from 24.0° to 26.0°Celsius.

Salinity during the November-December sampling ranged from 32.5 to 35.5 parts per thousand, typical of open gulf waters not strongly influenced by coastal runoff. Salinities during May were slightly lower, ranging from 29.0 to 32.0 parts per thousand. The extremely low values recorded, 14.5 to 27.0 parts per thousand (Table 6), are believed to be due to instrument malfunction.

Table 5. Water temperature, salinity, and dissolved oxygen data for the November-December 1979 sampling at all stations.

Station	Temperature (°C)		Dissolved Oxygen(ppm)		Salinity (ppt)	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
1-1	17.0	+[1]	8.3	+	33.0	+
2-1	17.5	+	8.4	+	33.0	+
3-1	17.5	+	8.2	+	32.5	+
4-1	17.0	+	*[2]	+	33.5	+
5-1	18.0	+	7.7	+	34.0	+
6-1	19.0	+	8.3	+	33.5	+
7-1	19.0	+	8.0	+	33.5	+
8-1	18.5	+	8.3	+	33.5	+
9-1	20.0	+	7.8	+	33.5	+
1-2	18.0	+	8.3	+	33.0	+
2-2	18.0	+	8.4	+	33.5	+
3-2	17.5	+	8.4	+	33.0	+
4-2	18.0	+	*	+	33.5	+
5-2	18.0	+	7.7	+	34.0	+
6-2	19.5	+	7.8	+	33.5	+
7-2	19.5	+	7.6	+	33.5	+
8-2	19.0	+	7.7	+	33.5	+
9-2	20.0	+	7.8	+	33.5	+
1-3	18.0	19.0	7.7	7.7	34.0	34.0
2-3	18.0	18.5	8.0	7.8	34.0	34.0
3-3	19.0	19.0	7.9	7.8	34.0	34.0
4-3	18.5	18.0	8.1	8.0	33.5	33.5
5-3	17.5	17.5	7.9	7.6	33.5	34.0
6-3	19.0	19.5	7.7	7.2	34.0	34.0
7-3	18.5	19.0	8.1	7.9	34.0	34.0
8-3	16.5	16.5	8.2	8.0	34.0	34.0
9-3	20.0	20.0	7.8	7.5	33.5	34.0
1-4	18.0	19.0	7.9	8.0	34.0	34.0
2-4	18.0	18.5	7.8	7.7	33.5	34.0
3-4	19.0	18.5	7.3	6.7	33.5	34.0
4-4	19.0	19.0	8.0	7.8	33.5	33.5
5-4	18.0	18.0	8.6	8.6	34.0	34.0
6-4	19.0	19.0	7.8	7.5	34.0	34.0
7-4	19.5	20.0	8.2	7.8	34.0	34.5
8-4	16.5	17.0	8.2	8.0	34.0	34.0
9-4	19.5	20.0	7.7	7.5	34.5	34.5
1-5	18.5	19.0	7.7	7.7	34.0	34.0
2-5	18.0	18.5	7.8	7.7	33.5	34.0
3-5	19.0	18.0	7.4	7.9	34.0	34.5
4-5	19.5	19.5	7.7	7.6	33.5	33.5
5-5	18.0	18.5	7.9	7.7	34.0	34.0
6-5	19.5	21.0	7.7	7.1	35.5	35.0
7-5	20.0	20.5	8.0	7.7	35.5	35.0
8-5	20.0	20.5	8.1	7.7	35.0	35.0
9-5	19.0	19.0	7.7	7.2	34.5	34.5
Control Sites C A	18.5	18.0	7.3	7.3	33.5	34.0
C B	20.0	20.5	7.7	7.5	35.0	35.0
Borrow Sites B 1	18.0	17.5	7.7	7.8	34.0	34.0
B 2	17.0	18.0	7.9	7.4	33.5	33.5

+[1] indicates water too shallow for two readings.
*[2] indicates instrument malfunction.

Table 6. Water temperature, salinity, and dissolved oxygen data for the May 1980 sampling at all stations.

Station	Temperature (°C) Surface	Temperature (°C) Bottom	Dissolved Oxygen (ppm) Surface	Dissolved Oxygen (ppm) Bottom	Salinity (ppt) Surface	Salinity (ppt) Bottom
1-1	26.0	+[1]	5.5	+	30.0	+
2-1	25.5	+	5.5	+	30.0	+
3-1	26.0	+	5.5	+	30.5	+
4-1	26.0	+	5.2	+	29.5	+
5-1	26.0	+	5.3	+	30.0	+
6-1	26.0	+	5.5	+	30.5	+
7-1		*[2]		*		*
8-1		*		*		*
9-1	25.0	+	5.8	+	23.0[3]	+
1-2	25.5	25.5	5.3	5.3	30.5	30.5
2-2	25.5	25.5	5.4	5.4	30.0	30.0
3-2	26.0	26.0	5.5	5.5	30.0	30.0
4-2	26.0	26.0	5.1	5.1	30.0	30.0
5-2	26.0	26.0	5.2	5.2	29.5	29.5
6-2	26.0	26.0	5.4	5.4	30.5	30.5
7-2		*		*		*
8-2		*		*		*
9-2	25.0	25.2	5.3	5.2	27.0[3]	24.0[3]
1-3	25.0	25.0	5.2	5.1	30.0	30.5
2-3	25.0	25.0	5.0	4.8	31.5	32.0
3-3	25.5	25.0	5.0	4.9	31.0	31.5
4-3	25.0	24.2	5.1	4.9	31.0	31.0
5-3	25.5	24.5	5.2	5.2	31.5	31.5
6-3	25.5	25.0	5.3	5.3	31.0	31.0
7-3	25.0	25.0	5.7	5.5	31.5	30.5
8-3	25.5	25.0	5.1	5.4	30.0	30.5
9-3	25.0	24.0	5.1	4.9	23.0[3]	22.5[3]
1-4	25.0	25.0	5.3	5.2	30.0	30.5
2-4	25.0	24.5	5.0	5.0	32.0	31.5
3-4	25.2	25.0	5.0	4.9	30.5	31.0
4-4	25.0	24.5	5.0	4.9	31.5	31.5
5-4	25.0	25.0	5.1	5.1	31.5	31.5
6-4	25.3	25.3	5.5	5.4	31.5	31.0
7-4	25.0	25.0	5.5	5.2	31.5	33.0
8-4	25.0	25.3	5.1	5.3	29.0	29.0
9-4	25.5	24.5	5.3	5.3	23.0[3]	23.0[3]
1-5	25.0	25.0	5.2	5.0	31.5	31.5
2-5	25.0	25.0	4.9	4.9	31.5	32.0
3-5	25.0	24.5	5.0	4.9	31.5	31.0
4-5	25.0	24.5	5.0	4.8	31.5	31.5
5-5	25.0	25.0	5.0	5.0	31.5	31.5
6-5	25.5	25.0	5.3	5.2	31.5	31.5
7-5	25.3	25.3	5.4	5.5	30.5	30.5
8-5	25.5	25.5	5.5	5.5	29.0	29.0
9-5	25.2	25.0	5.2	5.8	14.5[3]	18.0[3]
Control Sites C A	25.0	24.2	5.1	5.1	31.0	31.0
C B	25.5	25.5	5.2	5.2	29.0	29.0
Borrow Sites B 1	25.0	25.0	5.4	5.2	31.0	31.5
B 2	25.0	25.0	5.4	5.2	31.0	31.5

+[1] indicates water too shallow for two readings.
*[2] indicates data were not obtained due to very rough seas.
[3] indicates probable instrument malfunction.

Dissolved oxygen values were higher in November-December than in May, reflecting the colder water temperatures. For November-December, dissolved oxygen values ranged from 7.1 to 8.6 parts per million and for May they ranged from 4.8 to 5.8 parts per million. Overall, the highest dissolved oxygen values were recorded at the surface of the shallow stations. All stations appeared to have relatively high dissolved oxygen values (near saturation), indicating that dissolved oxygen would not be a limiting factor in the distribution and abundance of the benthic fauna in the study area.

Spatially, all physical parameters varied very little for both sampling periods. Additionally, temperature, salinity, and dissolved oxygen were not indicative of stressful conditions. Therefore, they are not considered as controlling factors in the distribution of benthic fauna within the study area, provided the observations made during November-December and May are characteristic of conditions during the remainder of the year.

b. Comparison to Saloman's (1976) Study. Dissolved oxygen was not measured during Saloman's (1976) study. The values for temperature and salinity recorded during this study compare very favorably to the data compiled by Saloman (1976). The ranges of salinity and temperature are nearly identical for comparable sampling dates. As observed during this study, Saloman's data exhibited only low levels of spatial variation.

2. Topography.

Beach profiles were constructed for each of the nine transects (Fig. 4). Two additional stations sampled were used as nourishment borrow sites in July and August 1976. A special effort was made at these stations to detect any irregularities of bottom profile or type of substrata. Numerous nearshore to offshore as well as shoreline parallel bathymetric profiles were run over each borrow site to detect any depressions or irregular contours. No depressions or changes in bottom type could be detected either by fathometer traces or visual inspection by divers. The borrow sites were indistinguishable from undisturbed areas within the limits of detection methods used.

3. Sediment Characteristics.

a. Present Study. A total of 98 sediment samples from the November-December 1979 and May 1980 collections were analyzed for particle-size distribution, organic carbon, and carbonate. Summaries of the results of these analyses are presented in Table 7 (November-December 1979) and Table 8 (May 1980). A complete breakdown of the particle-size distribution by phi interval is given in Appendix A. Little variation was evident on a seasonal basis. For the November-December sampling mean grain size ranged from 1.35 to 2.50 phi; mean grain size ranged from 1.44 to 2.91 phi for the May sampling. Spatially, sediments gradually changed from coarser to finer grain size on transects from the shore to the outer stations. This change is due primarily to a shift from medium to fine sand particles. Most of the stations for both sampling periods were moderately to moderately well sorted, being somewhat coarse-skewed. The bulk of the sediments within the study area consisted of fine, medium, and coarse quartz sand.

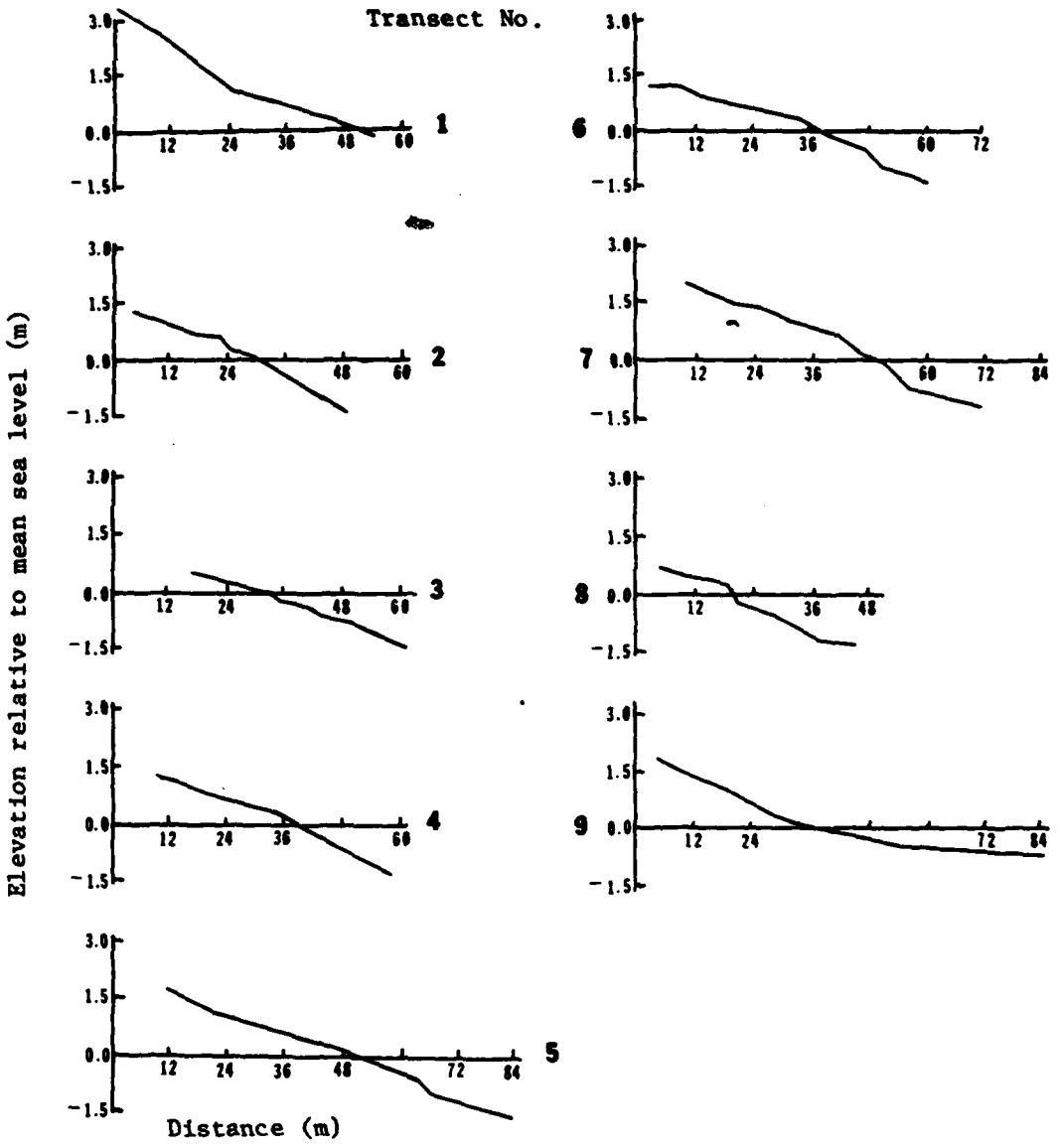

Figure 4. Beach profiles for the nine transect locations on the Panama City beaches, May 1980.

Table 7. Sediment parameters for all stations for the November-December 1979 sampling.

Station	Median Md	Mean Mz	Sorting σ	Skewness Sk	Kurtosis Kg	Pct silt-clay	Pct organic	Pct carbonate
1-1	1.74	1.65	0.97	-0.19	0.97	0.03	0.10	0.64
2-1	2.02	1.99	0.65	-0.05	0.75	0.03	0.03	0.16
3-1	1.70	1.79	0.73	0.08	0.95	0.02	0.04	0.05
4-1	2.66	2.07	0.71	0.07	1.19	0.02	0.03	0.14
5-1	1.95	1.94	0.73	-0.11	0.88	0.01	0.52	0.17
6-1	1.72	1.80	0.74	0.55	0.98	0.01	0.15	0.05
7-1	1.44	1.39	0.63	-0.07	1.34	0.01	0.09	0.28
8-1	1.43	1.38	0.64	-0.08	1.33	0.00	0.14	0.36
9-1	1.42	1.35	0.73	-0.10	1.25	0.01	0.14	0.36
Mean	1.79	1.71	0.73	0.01	1.07	0.02	0.14	0.25
Std. dev.	0.39	0.28	0.10	0.22	0.21	0.01	0.15	0.19
1-2	2.13	2.06	0.65	-0.15	0.76	0.02	0.07	0.21
2-2	2.09	2.04	0.65	-0.11	0.74	0.01	0.06	0.36
3-2	2.27	2.19	0.59	-0.21	0.85	0.02	0.03	0.11
4-2	2.10	2.05	0.63	-0.12	0.75	0.01	0.17	0.32
5-2	2.07	2.00	0.70	-0.18	0.84	0.01	0.24	0.42
6-2	2.22	2.15	0.62	-0.18	0.90	0.03	0.12	0.12
7-2	1.78	1.86	0.62	0.17	0.79	0.00	0.14	0.30
8-2	2.00	2.00	0.65	-0.01	0.63	0.00	0.07	0.00
9-2	2.19	2.12	0.61	-0.17	0.77	0.00	0.10	0.12
Mean	2.09	2.05	0.64	-0.11	0.78	0.01	0.11	0.22
Std. dev.	0.14	0.10	0.03	0.12	0.08	0.01	0.06	0.14
1-3	2.23	2.11	0.71	-0.32	0.96	0.01	0.16	0.96
2-3	2.28	2.20	0.59	-0.23	0.89	0.01	0.12	0.46
3-3	2.29	2.18	0.61	-0.27	0.89	0.03	0.16	0.64
4-3	2.41	2.41	0.47	-0.17	1.12	0.00	0.27	0.60
5-3	2.29	2.18	0.63	-0.28	0.92	0.01	0.16	0.50
6-3	2.43	2.43	0.46	-0.16	1.15	0.01	0.07	0.10
7-3	1.90	1.92	0.71	-0.03	0.84	0.03	0.14	0.13
8-3	1.70	1.73	0.82	-0.03	0.96	0.02	0.07	0.08
9-3	2.29	2.20	0.60	-0.25	0.91	0.01	0.14	0.18
Mean	2.20	2.15	0.62	-0.19	0.96	0.01	0.14	0.41
Std. dev.	0.24	0.22	0.11	0.11	0.11	0.01	0.06	0.30
1-4	2.48	2.49	0.38	-0.08	0.92	0.02	0.15	0.29
2-4	2.28	2.17	0.63	-0.27	0.89	0.00	0.28	0.75
3-4	2.35	2.26	0.59	-0.27	1.12	0.02	0.14	0.37
4-4	2.49	2.49	0.37	-0.01	0.96	0.01	0.19	0.45
5-4	2.30	2.17	0.65	-0.31	1.03	0.01	0.08	0.08
6-4	2.43	2.46	0.38	0.01	1.95	0.01	0.09	0.03
7-4	2.22	2.13	0.72	-0.17	0.78	0.04	0.11	0.03
8-4	2.20	2.09	0.68	-0.27	0.87	0.03	0.13	0.17
9-4	2.36	2.27	0.56	-0.30	1.41	0.01	0.09	0.02
Mean	2.35	2.28	0.55	-0.19	1.10	0.02	0.14	0.24
Std. dev.	0.11	0.16	0.14	0.13	0.37	0.01	0.06	0.25
1-5	2.35	2.25	0.60	-0.32	1.21	0.01	0.26	1.36
2-5	2.30	2.19	0.63	-0.29	0.91	0.01	0.13	0.31
3-5	2.39	2.34	0.53	-0.26	1.20	0.01	0.13	0.27
4-5	2.30	2.19	0.64	-0.35	0.99	0.01	0.07	0.06
5-5	2.42	2.41	0.05	-0.20	1.15	0.22	0.52	0.17
6-5	2.40	2.33	0.64	-0.33	1.45	0.03	0.07	0.18
7-5	2.43	2.44	0.50	-0.18	1.45	0.03	0.14	0.06
8-5	2.40	2.38	0.50	-0.22	1.17	0.04	0.38	1.20
9-5	2.49	2.50	0.47	-0.04	1.25	0.05	0.10	0.09
Mean	2.39	2.34	0.56	-0.24	1.20	0.05	0.20	0.41
Std. dev.	0.06	0.11	0.07	0.10	0.18	0.07	0.16	0.50
Control sites C A	2.40	2.32	0.62	-0.24	1.27	0.22	0.23	0.21
C B	2.31	2.19	0.70	-0.31	1.03	0.06	0.38	0.45
Mean	2.36	2.26	0.66	-0.28	1.15	0.14	0.31	0.33
Std. dev.	0.06	0.09	0.06	0.05	0.17	0.11	0.11	0.17
Borrow sites B 1	2.50	2.50	0.44	0.02	1.10	0.03	0.08	0.97
B 2	2.22	2.08	0.75	-0.33	0.95	0.01	0.42	0.22
Mean	2.36	2.29	0.60	-0.16	1.03	0.02	0.25	0.60
Std. dev.	0.20	0.30	0.22	0.25	0.11	0.01	0.24	0.53

Table 8. Sediment parameters for all stations for the May 1980 sampling.

Station	Median Md	Mean Mz	Sorting σ	Skewness Sk	Kurtosis Kg	Pct silt-clay	Pct organic	Pct carbonate
1-1	1.75	1.77	0.81	-0.05	0.93	0.05	0.06	0.46
2-1	2.30	2.21	0.59	-0.23	0.97	0.01	0.06	0.09
3-1	1.78	1.86	0.62	0.19	0.83	0.01	0.03	0.04
4-1	1.66	1.76	0.58	0.27	0.96	0.00	0.05	0.02
5-1	1.84	1.58	0.37	-0.96	0.76	0.00	0.06	0.03
6-1	1.75	1.80	0.64	0.16	0.82	0.01	0.03	0.06
7-1	1.47	1.49	0.61	0.34	1.37	0.01	0.05	0.02
8-1	1.45	1.44	0.59	-0.03	1.31	0.01	0.05	0.03
9-1	1.70	1.80	0.60	0.26	0.87	0.01	0.03	0.03
Mean	1.74	1.75	0.60	-0.01	0.98	0.01	0.05	0.09
Std. dev.	0.25	0.23	0.11	0.40	0.22	0.01	0.01	0.14
1-2	2.13	2.03	0.71	-0.25	0.86	0.01	0.08	0.73
2-2	2.39	2.33	0.53	-0.27	1.15	0.28	0.05	0.05
3-2	2.28	2.18	0.61	-0.26	0.89	0.00	0.05	0.12
4-2	2.34	2.27	0.55	0.25	1.10	0.02	0.07	0.04
5-2	2.27	2.18	0.60	-0.23	0.86	0.01	0.07	0.08
6-2	2.28	2.17	0.62	-0.28	0.88	0.01	0.06	0.06
7-2	2.20	2.12	0.62	-0.18	0.80	0.01	0.06	0.05
8-2	2.31	2.23	0.58	-0.24	0.98	0.00	0.06	0.05
9-2	2.12	2.07	0.62	-0.12	0.75	0.08	0.07	0.04
Mean	2.26	2.18	0.60	-0.18	0.92	0.05	0.06	0.14
Std. dev.	0.09	0.09	0.05	0.17	0.13	0.09	0.01	0.22
1-3	2.49	2.49	0.35	-0.07	0.88	0.01	0.08	0.59
2-3	2.20	2.11	0.57	-0.08	0.59	0.00	0.07	0.10
3-3	2.44	2.45	0.41	-0.14	1.15	0.00	0.30	0.06
4-3	2.30	2.23	0.56	-0.23	0.98	0.01	0.10	0.06
5-3	2.32	2.24	0.56	-0.25	0.95	0.00	0.06	0.06
6-3	2.28	2.18	0.60	-0.26	0.86	0.01	0.08	0.08
7-3	2.37	2.32	0.54	-0.23	1.09	0.02	0.08	0.04
8-3	2.12	2.05	0.67	-0.17	0.79	0.09	0.12	0.08
9-3	2.28	2.19	0.59	-0.24	0.90	0.01	0.08	0.06
Mean	2.31	2.25	0.54	-0.19	0.91	0.02	0.11	0.13
Std. dev.	0.11	0.15	0.10	0.07	0.16	0.03	0.07	0.18
1-4	2.44	2.43	0.48	-0.22	1.27	0.01	0.08	2.23
2-4	2.29	2.16	0.72	-0.34	1.01	0.01	0.06	0.15
3-4	2.90	2.91	0.73	-0.07	0.89	0.01	0.05	0.10
4-4	2.48	2.48	0.38	-0.10	0.97	0.01	0.11	0.06
5-4	2.38	2.32	0.53	-0.24	1.11	0.01	0.08	0.08
6-4	2.42	2.43	0.49	-0.18	1.26	0.00	0.08	0.08
7-4	2.18	2.06	0.69	-0.27	0.82	0.01	0.08	0.09
8-4	2.08	2.03	0.65	-0.11	0.75	0.01	0.06	0.11
9-4	2.12	2.03	0.72	-0.22	0.84	0.01	0.04	0.10
Mean	2.37	2.32	0.60	-0.19	0.99	0.01	0.07	0.33
Std. dev.	0.25	0.29	0.13	0.09	0.19	0.00	0.02	0.71
1-5	2.45	2.45	0.48	-0.16	1.10	0.01	0.09	0.33
2-5	2.29	2.18	0.63	-0.09	0.90	0.01	0.09	0.11
3-5	2.48	2.48	0.46	-0.21	1.19	0.02	0.08	0.16
4-5	2.16	1.96	0.85	-0.39	0.88	0.01	0.08	0.09
5-5	2.41	2.39	0.49	-0.21	1.22	0.00	0.06	0.05
6-5	2.35	2.28	0.56	-0.28	1.14	0.00	0.08	0.07
7-5	2.43	2.43	0.45	-0.15	1.13	0.05	0.10	0.05
8-5	2.22	2.13	0.56	-0.11	0.62	0.01	0.08	0.07
9-5	2.36	2.29	0.56	-0.26	1.14	0.02	0.09	0.09
Mean	2.35	2.29	0.56	-0.21	1.04	0.01	0.08	0.11
Std. dev.	0.11	0.17	0.12	0.09	0.20	0.02	0.01	0.09
Control sites C A	2.38	2.24	0.77	-0.36	1.68	0.03	0.07	0.16
C B	2.33	2.23	0.72	-0.19	1.21	0.07	0.12	0.17
Mean	2.36	2.24	0.75	-0.28	1.45	0.05	0.10	0.17
Std. dev.	0.04	0.01	0.04	0.12	0.33	0.03	0.04	0.01
Borrow sites B 1	2.40	2.38	0.49	-0.21	1.15	0.01	0.04	0.13
B 2	2.42	2.42	0.48	-1.38	1.19	0.01	0.23	0.08
Mean	2.41	2.40	0.49	-0.80	1.17	0.01	0.14	0.11
Std. dev.	0.01	0.03	0.01	0.83	0.03	0.00	0.13	0.04

There was very little silt-clay material in the surface sediments of the study area, ranging from 0.00 to 0.22 percent in November-December and 0.00 to 0.28 percent in May. There were no strong nearshore-offshore trends in the percentage of silt-clay.

The percentages of carbon within the sediments for both organic carbon and carbonate were also very low with little spatial or temporal variation. Organic carbon ranged from 0.03 to 0.52 percent in November-December and 0.03 to 0.30 percent in May. Carbon as carbonate ranged from 0.00 to 1.36 percent in November-December and from 0.02 to 2.23 percent in May. There were no strong nearshore-offshore trends for either organic carbon or carbonate. However, the nearshore stations 1 and 2 seemed to exhibit overall lower organic carbon values.

There were no discernible east-west trends among the sediment parameters. The surface sediments of the entire study area consist of fine to medium coarse quartz sands, containing very low levels of silt-clay, organic carbon, and carbonate.

The sediment parameters of the borrow sites B1 and B2 did not differ markedly from the control stations CA and CB, with the exception of a slightly greater percentage of fine sand at the borrow sites.

b. Comparisons to Saloman's (1976) Study. Comparisons of mean grain size, percent silt-clay, percent organic carbon and percent carbonate between this study and Saloman's (1974-75) data are presented in Tables 9 and 10. Only minor differences were found between the two studies. There is a slight but consistent increase of mean grain size (phi) from 1974-75 to 1979-80, indicating a slightly finer substrate composition in 1979-80 (see Fig. 5). However, the percentage of silt-clay material was apparently greater during 1974-75.

For both sampling periods the finest sediments (based on mean grain size) were recorded from the borrow sites, although they had nearly the lowest levels of silt-clay material. Comparisons of silt-clay percentages are shown in Figure 6.

The organic carbon and carbonate percentage values were higher during 1979-80 (0.03 to 0.52 percent organic carbon, 0.00 to 2.23 percent carbonate) than during 1974-75 (0.01 to 0.16 percent organic carbon, 0.00 to 0.77 percent carbonate). Comparisons are shown in Figures 7 and 8.

Only relatively small changes were found in the various sediment parameters between the current and 1974-75 data. Slight differences in processing techniques by the respective investigators and normal sampling variation would account for the observed changes.

4. Benthic Fauna.

a. Present Study. A total of 5,044 individuals, representing 128 taxa, were collected from 28 November to 1 December 1979 at the 49 benthic

Table 9. Comparison of mean grain size (phi), percent silt-clay, percent organic carbon and percent carbonate between November 1974 and November-December 1979 (Saloman, 1976) for all stations.

Station	Mean grain size (ϕ) 1974	1979	Pct silt-clay 1974	1979	Pct organic carbon 1974	1979	Pct carbonate 1974	1979
1-1	1.83	1.65	0.07	0.03	0.01[1]	0.10	0.01[1]	0.64
2-1	1.91	1.99	0.09	0.03	0.04	0.03	0.77	0.16
3-1	1.81	1.79	0.10	0.02	0.06	0.04	0.07	0.05
4-1	1.56	2.07	0.04	0.02	0.02	0.03	0.02	0.14
5-1	1.63	1.94	0.09	0.01	0.07	0.52	0.01	0.17
6-1	1.51	1.80	0.02	0.01	0.04	0.15	0.00	0.05
7-1	1.49	1.39	0.08	0.01	0.02	0.09	0.02	0.28
8-1	1.51	1.38	0.08	0.00	0.01	0.14	0.00	0.36
9-1	1.52	1.35	0.10	0.01	0.03	0.14	0.02	0.36
Mean	1.64	1.71	0.07	0.02	0.03	0.14	0.10	0.25
Std. dev.	0.16	0.28	0.03	0.01	0.02	0.15	0.25	0.19
1-2	1.60	2.06	0.09	0.02	0.06	0.07	0.03	0.21
2-2	2.14	2.04	0.21	0.01	0.04	0.06	0.11	0.36
3-2	2.00	2.19	0.11	0.02	0.03	0.03	0.04	0.11
4-2	1.93	2.05	0.14	0.01	0.01	0.17	0.01	0.32
5-2	1.89	2.00	0.05	0.01	0.02	0.24	0.01	0.42
6-2	1.68	2.15	0.03	0.03	0.06	0.12	0.02	0.12
7-2	1.70	1.86	0.03	0.00	0.04	0.14	0.00	0.30
8-2	1.90	2.00	0.05	0.00	0.04	0.07	0.60	0.00
9-2	1.75	2.12	0.07	0.00	0.02	0.10	0.02	0.12
Mean	1.84	2.05	0.09	0.01	0.04	0.11	0.10	0.22
Std. dev.	0.17	0.10	0.06	0.01	0.02	0.06	0.19	0.14
1-3	2.31	2.11	0.11	0.01	0.04	0.16	0.03	0.96
2-3	2.06	2.20	0.14	0.01	0.02	0.12	0.15	0.46
3-3	2.42	2.18	0.12	0.03	0.04	0.16	0.02	0.64
4-3	1.92	2.41	0.04	0.00	0.05	0.27	0.00	0.60
5-3	2.12	2.18	0.06	0.01	0.04	0.16	0.76	0.50
6-3	2.10	2.43	0.09	0.01	0.07	0.07	0.01	0.10
7-3	2.08	1.92	0.06	0.03	0.04	0.14	0.04	0.13
8-3	2.17	1.73	0.02	0.02	0.03	0.07	0.03	0.08
9-3	2.15	2.20	0.05	0.01	0.03	0.14	0.04	0.18
Mean	2.15	2.15	0.08	0.01	0.04	0.14	0.12	0.41
Std. dev.	0.14	0.22	0.04	0.01	0.01	0.06	0.24	0.30
1-4	2.27	2.49	0.14	0.02	0.04	0.15	0.03	0.29
2-4	1.86	2.17	0.04	0.00	0.06	0.28	0.01	0.75
3-4	2.17	2.26	0.08	0.02	0.05	0.14	0.03	0.37
4-4	2.21	2.49	0.04	0.01	0.07	0.19	0.01	0.45
5-4	2.36	2.17	0.12	0.01	0.07	0.08	0.01	0.08
6-4	2.32	2.46	0.06	0.01	0.07	0.09	0.00	0.03
7-4	1.99	2.13	0.03	0.04	0.04	0.11	0.02	0.03
8-4	2.06	2.09	0.04	[illegible]	0.03	0.13	0.03	0.17
9-4	1.73	2.27	0.12	[illegible]	0.04	0.09	0.02	0.02
Mean	2.11	2.28	0.07	0.02	0.05	0.14	0.02	0.24
Std. dev.	0.21	0.16	0.04	0.01	0.02	0.06	0.01	0.25
1-5	1.96	2.25	0.04	0.01	0.09	0.26	0.05	1.36
2-5	2.00	2.19	0.05	0.01	0.04	0.13	0.21	0.31
3-5	2.11	2.34	0.07	0.01	0.03	0.13	0.12	0.27
4-5	2.29	2.19	0.10	0.01	0.01	0.07	0.03	0.06
5-5	2.29	2.41	0.05	0.22	0.04	0.52	0.01	0.17
6-5	2.25	2.33	0.10	0.03	0.03	0.07	0.05	0.18
7-5	2.23	2.44	0.07	0.03	0.05	0.14	0.01	0.06
8-5	2.17	2.38	0.07	0.04	0.03	0.38	0.48	1.20
9-5	2.25	2.50	0.08	0.05	0.01	0.10	0.05	0.09
Mean	2.17	2.34	0.06	0.05	0.04	0.20	0.11	0.41
Std. dev.	0.12	0.11	0.03	0.07	0.02	0.16	0.15	0.50
Control sites C A	2.20	2.32	0.14	0.22	0.08	0.23	0.03	0.21
C B	2.21	2.19	0.13	0.06	0.08	0.38	0.02	0.45
Mean	2.21	2.26	0.14	0.14	0.08	0.31	0.03	0.33
Std. dev.	0.01	0.09	0.01	0.11	0.00	0.11	0.01	0.17
Borrow sites B 1	--[2]	2.50	--	0.03	--	0.08	--	0.97
B 2	--	2.08	--	0.01	--	0.42	--	0.22
Mean		2.29		0.02		0.25		0.60
Std. dev.		0.30		0.01		0.24		0.53

[1]From the December sediment analysis.
[2]No comparable data.

Table 10. Comparison of mean grain size (phi), percent silt-clay, percent organic carbon and percent carbonate between May 1975 and May 1980 (Saloman, 1976) for all stations.

Station	Mean grain size (ϕ)		Pct silt-clay		Pct organic carbon		Pct carbonate	
	1975	1980	1975	1980	1975	1980	1975	1980
1-1	2.08	1.77	0.07	0.05	0.01	0.06	0.11	0.46
2-1	1.42	2.21	0.01	0.01	0.16	0.06	0.12	0.09
3-1	1.58	1.86	0.02	0.01	0.12	0.03	0.01	0.04
4-1	1.52	1.76	0.00	0.00	0.03	0.05	0.70	0.02
5-1	1.68	1.58	0.00	0.00	0.15	0.06	0.17	0.03
6-1	1.70	1.80	0.00	0.01	0.04	0.03	0.09	0.06
7-1	1.66	1.49	0.00	0.01	0.02	0.05	0.03	0.02
8-1	1.43	1.44	0.00	0.01	0.04	0.05	0.00	0.03
9-1	1.15	1.80	0.00	0.01	0.02	0.03	0.01	0.03
Mean	1.58	1.75	0.01	0.01	0.07	0.05	0.14	0.09
Std. dev.	0.25	0.23	0.02	0.01	0.06	0.01	**0.22**	0.14
1-2	1.73	2.03	0.01	0.01	0.03	0.08	0.21	0.73
2-2	2.06	2.33	0.01	0.28	0.03	0.05	0.10	0.05
3-2	2.11	2.18	0.07	0.00	0.03	0.05	0.09	0.12
4-2	2.04	2.27	0.07	0.02	0.03	0.07	0.06	0.04
5-2	2.00	2.18	0.00	0.01	0.04	0.07	0.01	0.08
6-2	2.12	2.17	0.08	0.01	0.02	0.06	0.01	0.06
7-2	2.07	2.12	0.01	0.01	0.09	0.06	0.00	0.05
8-2	1.78	2.23	0.00	0.00	0.01	0.06	0.03	0.05
9-2	1.51	2.07	0.06	0.08	0.01	0.07	0.04	0.04
Mean	1.94	2.18	0.03	0.05	0.03	0.06	0.06	0.14
Std. dev.	0.21	0.09	0.03	0.09	0.02	0.01	0.07	0.22
1-3	2.28	2.49	0.02	0.01	0.08	0.08	0.01	0.59
2-3	2.41	2.11	0.04	0.00	0.01	0.07	0.01	0.10
3-3	2.41	2.45	0.08	0.00	0.05	0.30	0.02	0.06
4-3	2.45	2.23	0.07	0.01	0.03	0.10	0.04	0.06
5-3	2.35	2.24	0.06	0.00	0.04	0.06	0.04	0.06
6-3	2.44	2.18	0.04	0.01	0.05	0.08	0.24	0.08
7-3	2.43	2.32	0.16	0.02	0.01	0.08	0.05	0.04
8-3	2.18	2.05	0.01	0.09	0.05	0.12	0.00	0.08
9-2	2.36	2.19	0.06	0.01	0.01	0.08	0.01	0.06
Mean	2.37	2.25	0.06	0.02	0.04	0.11	0.05	0.13
Std. dev.	0.09	0.15	0.04	0.03	0.02	0.07	0.07	0.18
1-4	1.89	2.43	0.00	0.01	0.06	0.08	0.04	2.23
2-4	1.94	2.16	0.01	0.01	0.03	0.06	0.20	0.15
3-4	2.15	2.91	0.02	0.01	0.05	0.05	0.01	0.10
4-4	2.22	2.48	0.03	0.01	0.03	0.11	0.03	0.06
5-4	2.15	2.32	0.00	0.01	0.03	0.08	0.04	0.08
6-4	2.21	2.43	0.01	0.00	0.04	0.08	0.10	0.08
7-4	2.33	2.06	0.10	0.01	0.01	0.08	0.04	0.09
8-4	2.45	2.03	0.13	0.01	0.01	0.06	0.03	0.11
9-4	2.36	2.03	0.11	0.01	0.03	0.04	0.00	0.10
Mean	2.19	2.32	0.05	0.01	0.03	0.07	0.05	0.33
Std. dev.	0.18	0.29	0.05	0.00	0.02	0.02	0.06	0.71
1-5	2.16	2.45	0.05	0.01	0.02	0.09	0.13	0.33
2-5	2.23	2.18	0.03	0.01	0.03	0.09	0.20	0.11
3-5	2.20	2.48	0.03	0.02	--	0.08	--	0.16
4-5	2.31	1.96	0.01	0.01	0.01	0.08	0.31	0.09
5-5	2.32	2.39	0.00	0.00	0.04	0.06	0.00	0.05
6-5	2.28	2.28	0.10	0.00	0.05	0.08	0.05	0.07
7-5	2.46	2.43	0.14	0.05	0.01	0.10	0.04	0.05
8-5	2.18	2.13	0.05	0.01	0.01	0.08	0.03	0.07
9-5	2.25	2.29	0.10	0.02	0.01	0.09	0.07	0.09
Mean	2.27	2.29	0.06	0.01	0.02	0.08	0.10	0.11
Std. dev.	0.09	0.17	0.05	0.02	0.02	0.01	0.10	0.09
Control sites C A	2.43	2.24	0.17	0.03	0.05	0.07	0.03	0.16
C B	2.33	2.23	0.00	0.07	0.01	0.12	0.07	0.17
Mean	2.38	2.24	0.17	0.05	0.03	0.10	0.05	0.17
Std. dev.	0.07	0.01	0.00	0.03	0.03	0.04	0.03	0.01
Borrow sites B 1	--	2.38	--	0.01	--	0.04	--	0.13
B 2	--	2.42	--	0.01	--	0.23	--	0.08
Mean		2.40		0.01		0.14		0.11
Std. dev.		0.03		0.00		0.13		0.04

[1] No comparable data.

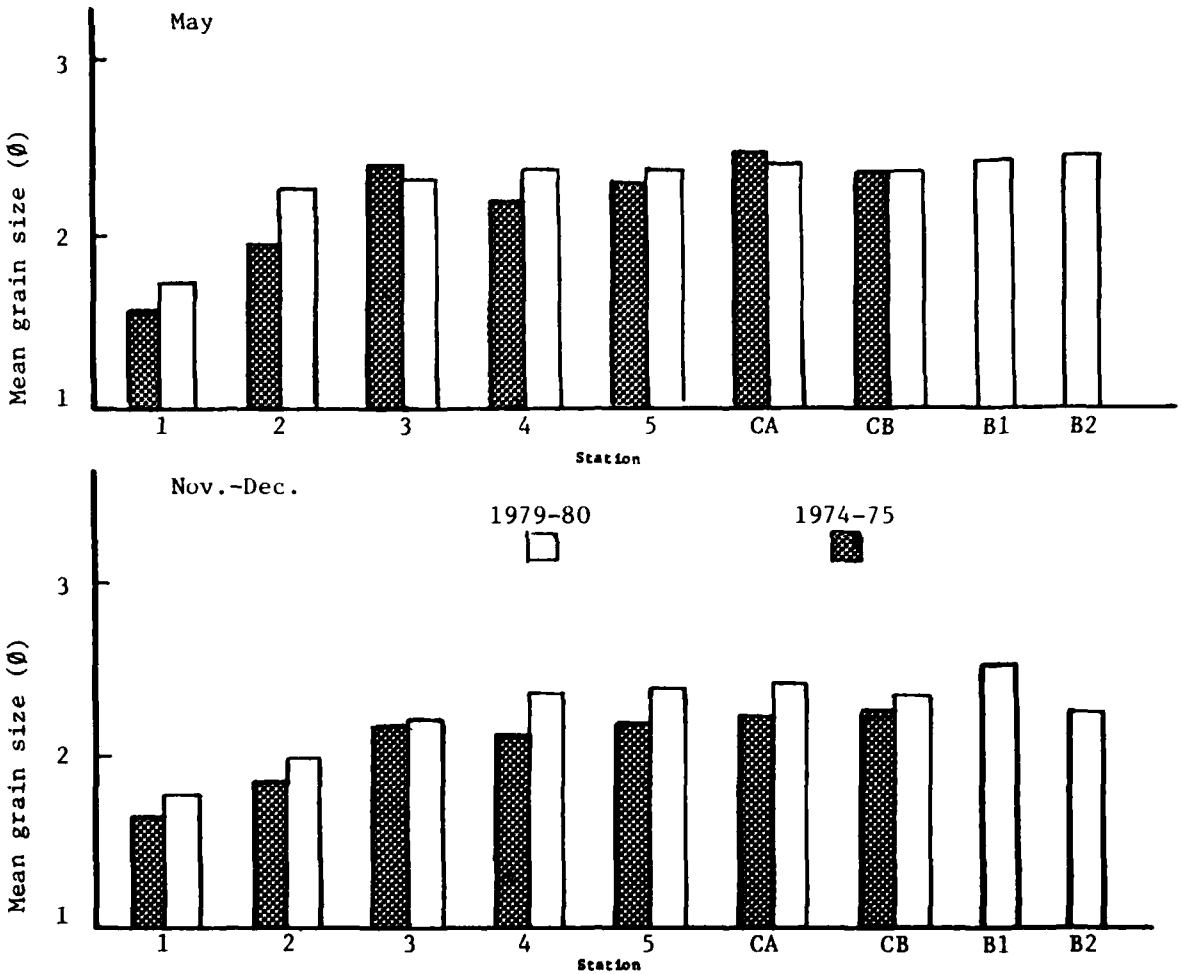

Figure 5. Graphic comparison of variations in mean grain size between the 1979-80 and the 1974-75 sediment collections for both November-December and May sampling periods.

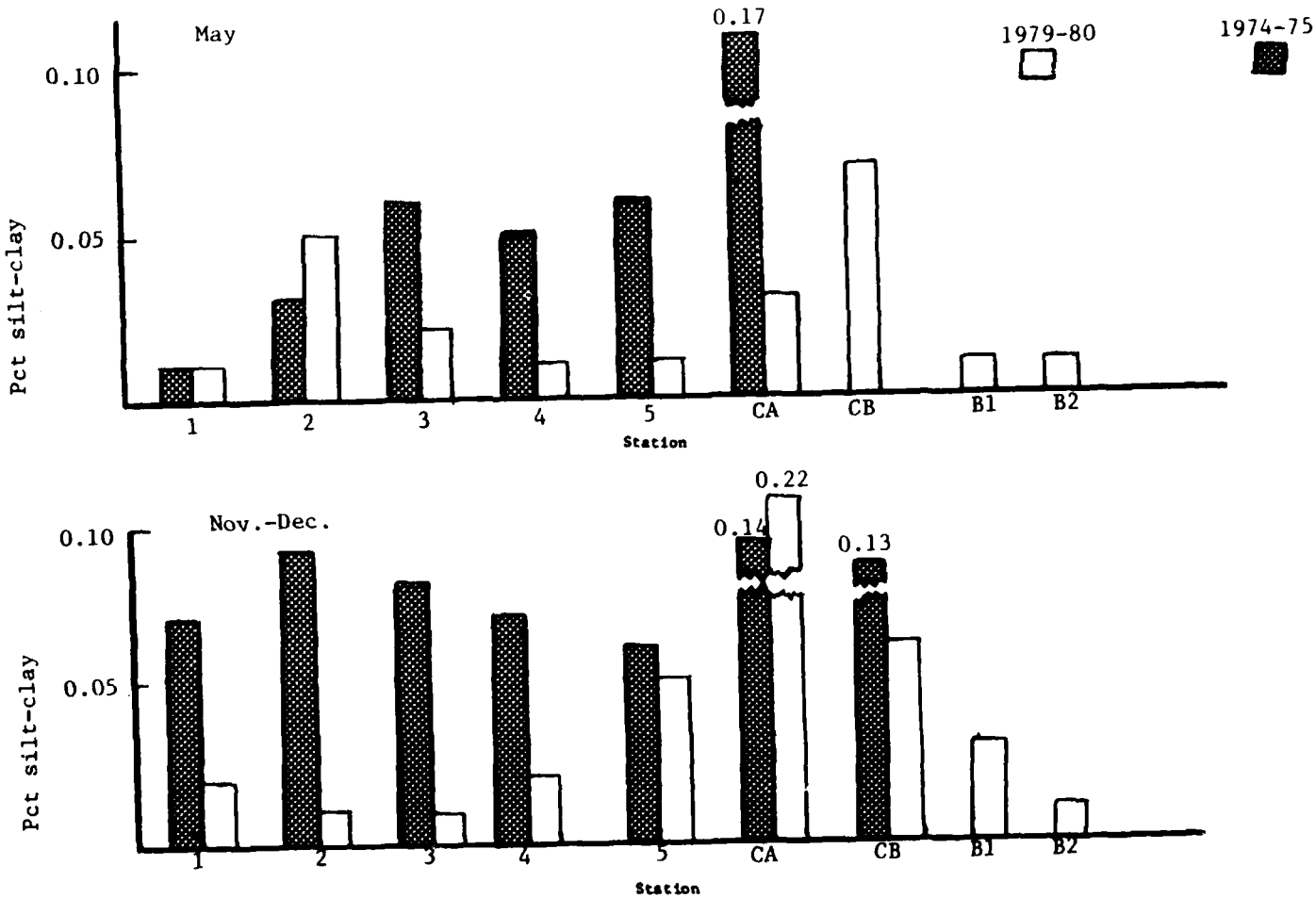

Figure 6. Graphic comparison of variations in percent silt-clay between the 1979-80 and the 1974-75 sediment collections for both November-December and May sampling periods.

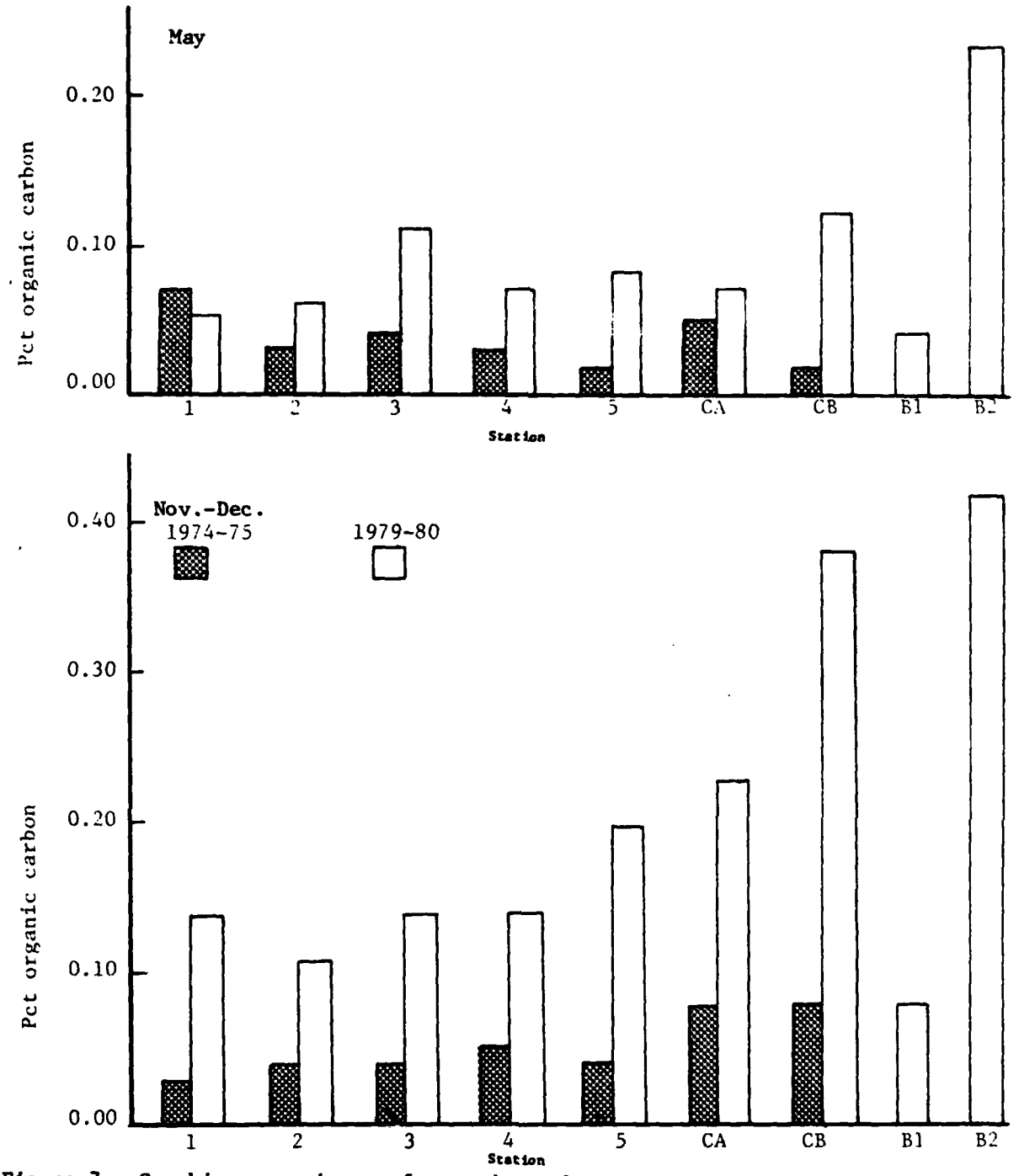

Figure 7. Graphic comparisons of organic carbon percentages for May and November-December between the 1974-75 and 1979-80 collections.

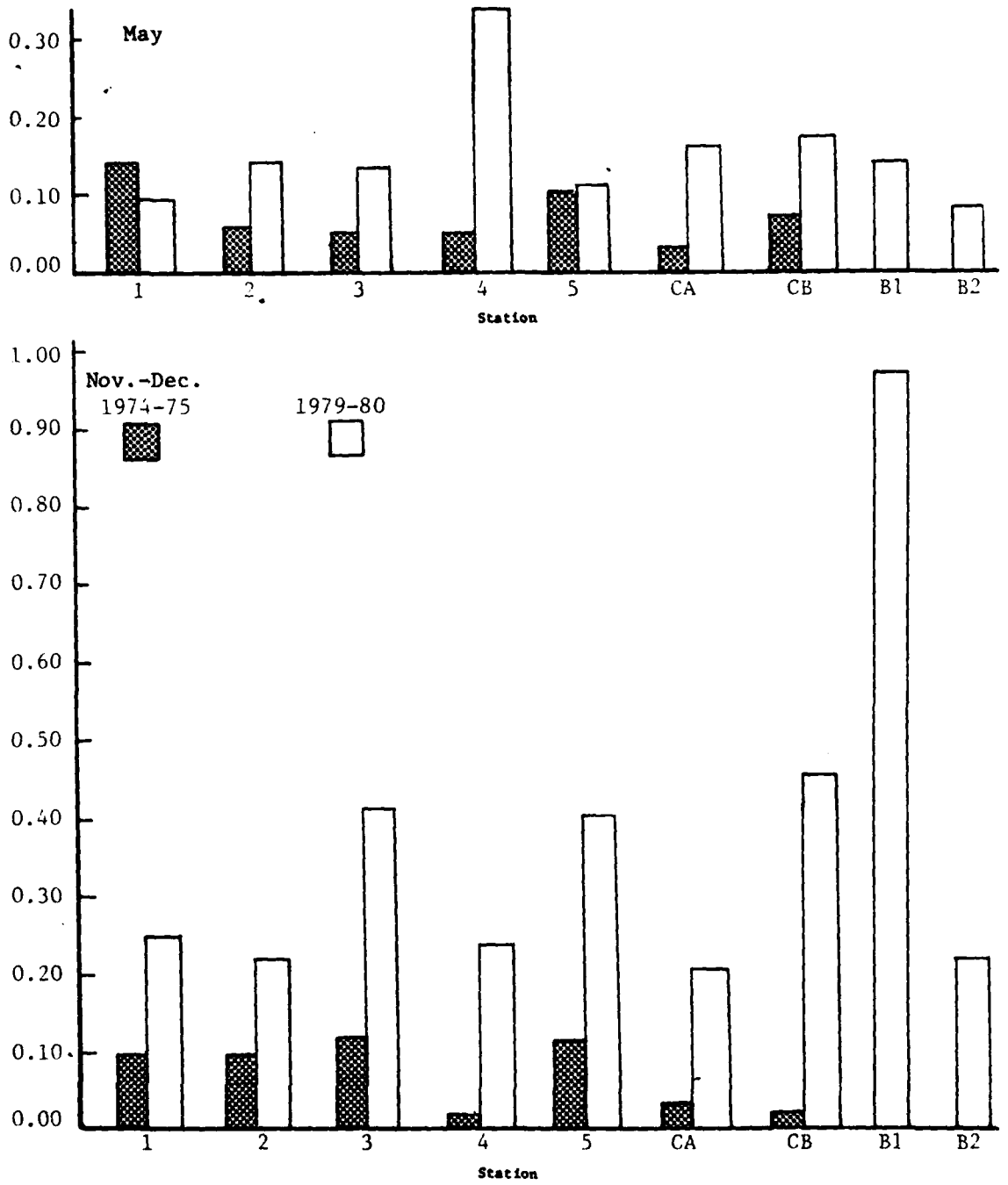

Figure 8. Graphic comparisons of carbonate percentages for May and November-December between the 1974-75 and 1979-80 collections.

stations; 5,959 individuals, representing 125 taxa, were collected from 19 to 23 May 1980. Composite species lists and faunal counts for all stations for each sampling period are presented in Appendix B. A checklist of species collected during this study (Table 11) lists 162 taxa representing 14 animal phyla.

(1) Species Composition. Of the 128 taxa collected in November-December, the most abundant group was the polychaetes (36 species), followed by bivalves (14 species), gastropods (13 species), amphipods (10 species), and brachyurans (10 species). For May, the same groups were again dominant: polychaetes (36 species), gastropods (15 species), amphipods (12 species), bivalves (11 species), and brachyurans (9 species). These data are presented in Table 12. Other major groups were represented by few species and composed only a small percentage of the total fauna.

For November-December, the most abundant species at transect stations 2 to 5 was the polychaete *Paraonis fulgens* (25, 30, 42, and 22 percent of total fauna). For station 1 the polychaete *Scolelepis squamata* was dominant (55 percent) At station 2 the bivalve *Donax texasianus* (15 percent), the amphipod *Haustorius* n. sp., a new undescribed species (11 percent), and the mysid *Boumaniella* spp. (11 percent) were also dominant taxa. The amphipods *Acanthohaustorius* sp., *Protohaustorius* n. sp., and *Pseudohaustorius* n. sp., were important faunal components at stations 3, 4, and 5. Table 13 presents the dominant fauna for stations 1 to 5 for the November-December sampling. Table 14 lists the dominant fauna for stations CA and CB. These stations were characterized by a lower level of oligomixity. The amphipod *Protohaustorius* n. sp. (15 percent) was the most abundant species at station CA; an unidentified nematode (22 percent) the amphipod *Pseudoplatyischnopus* n. spp. (15 percent) and an unidentified oligochaete (14 percent) were dominant at station CB.

For May (Table 15) the polychaete *Scolelepis squamata* (90 percent) was singly dominant at station 1 and was also abundant at station 2 (21 percent). *Paraonis fulgens* was again abundant at stations 3 (10 percent), 4 (42 percent), and 5 (18 percent). Also common at station 3 was the echinoderm *Mellita quinquiesperforata* (15 percent), the amphipod *Protohaustorius* n. sp. (13 percent), and the polychaete *Spiophanes bombyx* (10 percent); at station 4 the amphipods *Acanthohaustorius* sp. (8 percent) and *Protohaustorius* n. sp. (9 percent) were common; and at station 5 the amphipod *Protohaustorius* n. sp. (28 percent) and the polychaete *Nephtys picta* (7 percent) were abundant. Stations CA and CB showed a higher level of oligomixity for May than for November-December, but again it appeared lower than for the transect stations. At station CA the amphipod *Protohaustorius* n. sp. (27 percent) and the polychaete *Myriochele oculata* (14 percent) were abundant; at station CB the bivalve *Pitar simpsoni* (35 percent) and the amphipods *Pseudoplatyischnopus* n. spp. (12 percent) and *Protohaustorius* n. sp. (12 percent) were the most numerous.

Table 11. Checklist of benthic fauna collected from the Panama City beaches.

CNIDARIA
HYDROZOA
Hydroid sp.
ANTHOZOA
Anthenaria sp.
Anemone sp.
PLATYHELMINTHES
Stylochus sp.
NEMERTINEA
Unidentified sp.
NEMATODA
Unidentified sp.
BRYOZOA
Unidentified sp.
GASTROTRICHA
Unidentified sp.
PHORONIDA
Phoronis architecta
SIPUNCULIDA
Sipunculus longipapillosus
ANNELIDA
OLIGOCHAETA
Unidentified sp.
POLYCHAETA
Apoprionospio pygmaea
Archiannelida sp.
Aricidea fragilis
Armandia agilis
Armandia maculata
Brania clavata
Brania wellfleetensis
Capitella capitata
Caulleriella sp.
Dispio uncinata
Drilonereis sp. A
Eteone heteropoda
Eteone lactea
Glycera americana
Glycinde solitaria
Lumbrineris parvapedata
Magelona riojai
Melinna maculata
Minuspio cirrifera
Myriochele oculata
Nephtyidae sp. (juv.)
Nephtys bucera
Nephtys picta
Nereis succinea
Nereis sp.
Onuphis eremita oculata
Ophelia sp.

POLYCHAETA (cont.)
Paraonis fulgens
Paraprionospio pinnata
Pectinaria gouldii
Phyllodoce arenae
Pista palmata
Polydora ligni
Polynoidea sp. A
Polynoidea sp. B
Prionospio cristata
Protodorvillea sp.
Scolelepis squamata
Scoloplos foliosus
Scoloplos robustus
Scoloplos rubra
Sigambra bassi
Spio pettiboneae
Spionid sp. A
Spiophanes bombyx
Polychaeta sp. A
Polychaeta sp. B
Polychaeta sp. C
Polychaeta sp. D
Polychaeta sp. F
Polychaeta sp. G
MOLLUSCA
GASTROPODA
Acteonidae sp. (juv.)
Anachis pulchella
Arene tricarinata
Caecum sp.
Cyclostremiscus sp.
Cylichnella bidentata
Mitrella lunata
Nassarius acutus
Natica pusilla
Odostominae sp.
Oliva sayana
Oliva sp.
Olivella dealbata
Olivella mutica
Polinices duplicatus
Terebra dislocata
Terebra salleana
Tonnidae sp.
Gastropoda sp. C
Gastropoda sp. (juv.)
Nudibranch sp. (juv.)

BIVALVIA
Cuna dalli
Dinocardium robustum
Donax texasianus
Ervilia concentrica
Lepton sp.
Lucina multilineata
Macrocallista nimbosa
Musculus sp.
Periploma inequale
Pitar simpsoni
Solenidae sp.
Strigilla mirabilis
Strigilla sp.
Tellina sp.
Tellina versicolor
Veneridae sp.
ARTHROPODA
CRUSTACEA
COPEPODA
Unidentified sp.
CUMACEA
Cyclaspis varians
Mancocuma sp.
Oxyurostylis smithi
Cumucea sp. A
Cumucea sp. B
Cumucea sp. D
Cumucea sp. (frag.)
OSTRACODA
Haplocytherida setipunctata
Sarsiella sp.
Unidentified sp. A
Unidentified sp. B
ISOPODA
Ancinus depressus
Chiridotea excavata
Ianiropsis sp.
Idotea sp.
Idoteidae sp.
AMPHIPODA
Acanthohaustorius sp.
Ampelisca sp. B
Haustoridae sp. (juv.)
Haustorius n. sp.
Hyperiidea sp.
Lembos cf. *websteri*
Listriella cf. *barnardi*
Monoculodes nyei

AMPHIPODA (cont.)
Monoculodes sp.
Parahaustorius n. spp.
Platyischnopus sp.
Protohaustorius n. sp.
Pseudohaustorius n. sp
Pseudoplatyischnopus n. spp.
PENAEIDEA
Lucifer faxoni
CARIDEA
Caridea sp.
Ogyrides alphaerostris
Processa hemphilli
Processa sp.
MACRURA
Callianassa sp.
ANOMURA
Albunea paretii
Emerita benedicti
Emerita talpoida
Lepidopa benedicti
Paguridae (juv.)
Pagurus longicarpus
Pagurus sp.
Strigilla mirabilis (juv.)
Anomura sp. (juv.)
BRACHYURA
Dissodactylus mellitae
Ovalipes floridanus
Ovalipes ocellatus
Persephona mediterreanea
Pinnixa chacei
Pinnixa chaetopterana
Pinnixa cristata
Pinnixa retinens
Pinnixa sp.
Pinnotheridae sp.
Portunidae (juv.)
Xanthidae sp.
STOMATOPODA
Coronis excavatrix
ECHINODERMATA
ECHINOIDEA
Mellita quinquiesperforata
HOLOTHUROIDEA
Unidentified sp. A
OPHIUROIDEA
Ophiophragmus wurdemani
CHAETOGNATHA
Unidentified sp.
CEPHALOCHORDATA
Branchiostoma floridae

Table 12. Relative number of species and percentage of total faunal composition over all stations for the November-December 1979 and the May 1980 sampling at the Panama City beaches.

Major taxon	Nov.-Dec. 1979 No. of species	Nov.-Dec. 1979 Pct of total fauna	May 1980 No. of species	May 1980 Pct of total fauna
CNIDARIA	3	0.10	1	0.17
PLATYHELMINTHES	1	0.30	1	0.02
NEMERTINEA	1	1.45	1	1.33
NEMATODA	1	4.46	1	1.01
BRYOZOA	--	--	--	0.02
GASTROTRICHA	1	0.10	--	--
PHORONIDA	--	--	1	0.62
SIPUNCULIDA	1	0.02	--	--
OLIGOCHAETA	1	3.03	1	0.35
POLYCHAETA	36	44.21	36	52.96
GASTROPODA	13	1.15	15	1.04
BIVALVIA	14	2.86	11	6.48
COPEPODA	1	0.54	1	0.03
CUMACEA	4	0.61	6	0.77
OSTRACODA	4	0.12	1	0.05
ISOPODA	2	0.24	5	1.26
AMPHIPODA	10	32.06	12	23.97
PENAEIDEA	1	0.06	1	0.05
CARIDEA	3	0.57	3	0.23
MACRURA	--	--	1	1.11
ANOMURA	7	1.39	9	1.90
BRACHYURA	10	1.97	9	2.62
MYSIDACEA	9	2.87	5	0.49
STOMATOPODA	--	--	1	0.05
ECHINOIDEA	1	1.43	1	3.99
HOLOTHUROIDEA	1	0.02	--	--
OPHIUROIDEA	1	0.04	--	--
CHAETOGNATHA	1	0.20	1	0.10
CEPHALOCHORDATA	1	0.30	1	0.10
Total	128	100.00	125	100.00

Table 13. Percentage composition of the dominant fauna based on numbers of animals cumulatively comprising 80 percent or more of the total station fauna for all stations for the November 1974 and November-December 1979 sampling periods.

	Station									
	1		2		3		4		5	
Species	1974	1979	1974	1979	1974	1979	1974	1979	1974	1979
NEMERTINEA										
Unidentified sp.	--	--	--	--	--	--	--	2.03	--	--
NEMATODA										
Unidentified sp.	--	14.67	--	--	--	3.64	--	--	--	2.23
ANNELIDA										
OLIGOCHAETA										
Unidentified spp.	--	--	--	8.04	--	--	--	--	--	3.71
POLYCHAETA										
Brania wellfleetensis	--	--	--	--	--	--	--	--	--	4.88
Dispio uncinata	--	--	--	--	--	2.63	--	4.06	--	--
Magelona riojai	--	--	--	--	--	2.02	--	--	--	--
Paraonis fulgens	--	--	--	25.00	--	30.00	--	42.13	--	22.69
Scolelepis squamata	--	55.24	--	4.02	--	1.31	--	--	--	--
Scoloplos foliosus	--	--	--	--	--	2.32	--	--	--	--
Spio pettiboneae	--	--	--	--	--	1.31	--	--	--	2.56
Spiophanes bombyx	--	--	--	--	--	2.53	--	--	--	--
MOLLUSCA										
BIVALVIA										
Cuna dalli	--	--	--	--	--	2.63	--	--	--	--
Donax texasianus	64.37	--	68.53	15.63	--	--	--	--	--	--
Ervilia concentrica	--	--	--	--	6.41	--	--	--	--	--
Veneridae sp.	--	--	--	--	--	1.62	--	--	--	--
ARTHROPODA										
CRUSTACEA										
CUMACEA										
Manocuma sp.	--	--	--	4.02	--	--	--	--	--	--
AMPHIPODA										
Acanthohaustorius sp.	--	--	--	--	40.16	17.68	47.26	13.72	20.54	13.78
Haustorius sp.	27.59	--	24.37	11.16	--	--	--	--	--	--
Monoculodes nyei	--	--	--	--	--	1.92	--	--	--	--
Protohaustorius n. sp.	--	--	--	--	6.06	5.35	--	8.20	13.58	18.15
Pseudohaustorius n. sp.	--	--	--	--	14.69	3.74	11.75	10.31	20.20	13.61
ANOMURA										
Emerita talpoida	--	7.43	--	--	--	--	--	--	--	--
BRACHYURA										
Pinnixa retinens	--	--	--	4.91	--	--	--	--	--	--
MYSIDACEA										
Bowmaniella spp.	--	--	--	11.38	--	--	--	--	--	--
Mysidopsis bahia	--	5.90	--	--	--	--	--	--	--	--
ECHINODERMATA										
ECHINOIDEA										
Mellita quinquiesperforata	--	--	--	--	--	2.12	--	--	--	--
CEPHALOCHORDATA										
Branchiostoma floridae	--	--	--	--	17.45	--	23.11	--	27.16	--
Total	91.96	83.24	92.90	84.16	84.77	80.82	82.12	80.45	81.48	81.61
No. of species	2	4	2	8	5	15	3	6	4	8

Table 14. Percentage composition of the dominant fauna based on numbers of animals cumulatively comprising 80 percent or more of the total station fauna for control sites CA and CB for the 1974-75, 1979-80 studies, and the borrow sites B1 and B2 for the 1979-80 study.

Species	Station											
	Control CA		Control CB		Control CA		Control CB		Borrow site B1		Borrow site B2	
	Nov. 1974	Nov.-Dec. 1979	Nov. 1974	Nov.-Dec. 1979	May 1975	May 1980	May 1975	May 1980	Nov.-Dec. 1979	May 1980	Nov.-Dec. 1979	May 1980
NEMERTINEA												
Unidentified sp.	—	—	—	1.86	2.34	2.96	—	—	—	—	—	—
NEMTAODA												
Unidentified spp.	—	6.82	—	21.93	2.34	4.44	3.49	1.76	—	—	—	—
PHORONIDA												
Phoronis architecta	—	—	—	—	—	—	—	8 80	—	—	—	—
ANNELIDA												
OLIGOCHAETA												
Unidentified sp.	17.05	4.55	7.59	13.75	1.67	—	—	—	—	—	—	—
POLYCHAETA												
Armandia maculata	—	—	4.64	—	6.02	—	6.98	2.11	—	—	—	—
Brania clavata	—	—	—	2.97	—	—	—	—	—	—	—	—
Brania wellfleetensis	—	3.41	—	—	—	—	—	—	—	—	—	—
Magelona riojai	—	3.41	—	—	—	—	—	—	—	—	—	—
Myriochele oculata	—	—	—	—	—	14.07	—	—	—	—	—	—
Nephtys picta	—	—	—	—	2.34	8.89	—	2.46	—	5.80	—	12.28
Nereis sp.	—	2.27	—	—	—	—	—	—	—	—	—	—
Ophelia sp.	—	—	2.80	—	—	—	—	—	—	—	—	—
Paraonides lyra	14.73	—	—	—	—	—	—	—	—	—	—	—
Paraonis fulgens	—	3.41	—	5.95	—	3.70	—	—	49.46	—	—	7.02
Paraprionospio pinnata	13.18	—	4.22	—	—	—	—	—	—	—	—	—
Phyllodoce sp.	—	—	—	—	1.67	—	—	—	—	—	—	—
Prionospio cristata	36.43	—	56.54	—	—	—	—	—	—	—	—	—
Scolelepis squamata	—	—	—	—	—	—	—	—	4.35	—	—	—
Scolelepis texana	—	—	—	—	1.67	—	—	—	—	—	—	—
Scoloplos foliosus	—	2.27	—	—	—	—	—	—	—	—	—	—
Spio pettiboneae	—	—	—	—	3.01	—	6.40	—	—	—	—	—
Spiophanes bombyx	—	6.82	—	2.97	14.05	—	8.43	2.11	—	5.80	—	—
MOLLUSCA												
GASTROPODA												
Natica pusilla	—	2.27	—	—	—	—	—	—	—	—	—	—
Olivella dealbata	—	4.55	—	—	—	—	—	—	—	—	—	—
Oliva sp.	—	3.41	—	—	—	—	—	—	—	—	—	—
BIVALVIA												
Ervilia concentrica	—	—	—	—	—	4.44	—	—	—	—	—	—
Pitar simpsoni	—	—	—	—	—	—	—	34.51	—	—	—	—
Tellina versicolor	—	—	—	—	—	2.96	—	—	—	4.34	—	—
ARTHROPODA												
CRUSTACEA												
CUMACEA												
Cyclaspis varians	—	—	—	—	—	2.22	—	—	—	—	—	—
AMPHIPODA												
Acanthohaustorius sp.	—	2.27	—	—	2.68	—	4.65	—	—	4.34	11.58	19.30
Monoculodes nyei	—	—	—	1.86	—	2.22	—	3.52	9.78	23.19	13.68	15.79
Protohaustorius n. sp.	—	15.91	—	5.95	19.40	26.67	29.07	11.62	—	—	—	—
Pseudohaustorius n. sp.	—	4.55	—	—	—	—	—	—	19.02	18.84	55.79	—
Pseudoplatyischnopus n. sp.	—	7.95	—	15.24	—	7.41	—	12.32	—	—	—	—
COPEPODA												
Unidentified sp.	—	—	—	9.29	—	—	—	—	—	—	—	—
BRACHYURA												
Dissodactylus mellitae	—	—	—	—	—	—	—	—	—	5.80	—	—
Pinnotheridae sp. (juv.)	—	—	—	—	—	—	—	—	—	—	—	8.77
CARIDEA												
Processa hemphilli	—	—	—	—	2.34	—	—	—	—	—	—	—
ECHINODERMATA												
ECHINOIDEA												
Mellita quinquies-perforata	—	3.41	—	—	—	2.96	—	1.76	—	17.39	—	21.05
Unidentified sp.	—	—	—	—	3.68	—	—	—	—	—	—	—
CEPHALOCHORDATA												
Branchiostoma floridae	—	—	4.22	—	19.73	—	21.51	—	—	—	—	—
Total	81.39	77.28	81.01	81.77	82.94	82.94	80.53	80.97	82.61	85.50	81.05	84.21
No. of species	4	16	6	10	14	12	7	10	4	8	3	6

Table 15. Percentage composition of the dominant fauna based on numbers of animals comprising 80 percent or more of the total station fauna for all stations for the May 1975 and 1980 sampling periods.

	Station									
	1		2		3		4		5	
Species	1975	1980	1975	1980	1975	1980	1975	1980	1975	1980
NEMERTINEA										
Unidentified spp.	--	--	--	--	--	--	--	--	--	3.26
NEMATODA										
Unidentified spp.	--	--	--	--	--	--	--	--	--	3.15
ANNELIDA										
POLYCHAETA										
Armandia maculata	--	--	--	--	--	--	--	--	--	1.57
Dispio uncinata	--	--	--	--	--	2.61	--	3.26	--	--
Magelona riojai	--	--	--	--	--	3.96	--	--	3.27	--
Nephtys picta	--	--	--	--	--	4.50	--	6.15	--	7.09
Paraonis fulgens	--	--	--	26.80	--	10.09	--	42.41	2.92	17.89
Scolelepis squamata	57.30	90.22	--	20.53	--	--	--	--	--	--
Spio pettiboneae	--	--	--	--	--	--	--	--	12.36	--
Spiophanes bombyx	--	--	--	--	--	10.36	--	--	2.97	3.94
MOLLUSCA										
BIVALVIA										
Cuna dalli	--	--	--	--	--	2.25	--	--	--	--
Donax texasianus	38.29	--	80.85	13.63	50.78	--	38.06	--	--	--
ARTHROPODA										
CRUSTACEA										
ISOPODA										
Chiridotea excavata	--	--	--	--	--	--	--	3.14	--	3.26
AMPHIPODA										
Acanthohaustorius sp.	--	--	--	18.69	23.35	8.29	38.20	8.03	28.92	3.15
Parahaustorius n. sp.	--	--	--	3.13	--	--	--	--	--	--
Protohaustorius n. sp.	--	--	--	--	9.12	12.61	7.45	9.28	25.19	28.12
Pseudohaustorius n. sp.	--	--	--	--	--	5.32	--	--	6.24	4.16
Pseudoplatyischnopus n. spp.	--	--	--	--	--	--	--	--	--	3.60
MACRURA										
Callianassa sp.	--	--	--	--	--	3.78	--	--	--	1.46
BRACHYURA										
Dissodactylus mellitae	--	--	--	--	--	2.61	--	--	--	--
Pinnotheridae sp. (juv.)	--	--	--	--	--	--	--	4.27	--	--
ECHINODERMATA										
ECHINOIDEA										
Mellita quinquiesperforata	--	--	--	--	--	15.05	--	3.51	--	--
Total	95.59	90.22	80.85	82.78	83.25	81.43	83.71	80.05	81.87	80.65
No. of species	2	1	1	5	3	12	3	8	7	12

Table 16. Comparison of species richness (number of species) between November 1974 and November-December 1979 for all stations.

Station	No. of species 1974	1979	Station	No. of species 1974	1979	Station	No. of species 1974	1979
1-1	1	8	1-2	3	10	1-3	11	13
2-1	3	8	2-2	3	8	2-3	13	19
3-1	2	12	3-2	4	8	3-3	13	23
4-1	3	9	4-2	2	9	4-3	13	17
5-1	2	8	5-2	2	11	5-3	18	25
6-1	3	8	6-2	6	14	6-3	18	15
7-1	2	6	7-2	3	10	7-3	13	28
8-1	3	7	8-2	2	14	8-3	12	18
9-1	2	8	9-2	2	11	9-3	11	26
$\bar{x}$	2.3	8.2	$\bar{x}$	3.0	10.6	$\bar{x}$	13.6	20.4
Std. dev.	0.07	1.6	Std. dev.	1.3	2.2	Std. dev.	2.7	5.2
1-4	6	15	1-5	16	16	Control		
2-4	6	20	2-5	13	20	site C A	15	36
3-4	14	16	3-5	13	17	C B	26	39
4-4	11	23	4-5	8	12	$\bar{x}$	20.5	37.5
5-4	11	19	5-5	14	22	Std. dev.	7.8	2.1
6-4	8	13	6-5	14	29			
7-4	5	19	7-5	8	21	Borrow		
8-4	8	20	8-5	6	26	site B 1	—[1]	21
9-4	11	24	9-5	7	20	B 2	--	15
$\bar{x}$	8.9	18.8	$\bar{x}$	11.0	20.3	$\bar{x}$	—	18.0
Std. dev.	3.0	3.6	Std. dev.	3.7	5.1	Std. dev.	--	4.2

[1]No comparable data.

Table 17. Comparison of species richness (number of species) between May 1975 and May 1980 for all stations.

Station	No. of species 1975	1980	Station	No. of species 1975	1980	Station	No. of species 1975	1980
1-1	4	5	1-2	5	14	1-3	16	22
2-1	5	7	2-2	7	17	2-3	18	30
3-1	4	7	3-2	10	17	3-3	15	19
4-1	4	6	4-2	6	14	4-3	26	17
5-1	5	6	5-2	7	17	5-3	22	24
6-1	4	6	6-2	8	16	6-3	20	8
7-1	4	3	7-2	7	17	7-3	22	20
8-1	6	6	8-2	6	11	8-3	14	27
9-1	6	4	9-2	9	15	9-3	19	18
$\bar{x}$	4.7	5.6	$\bar{x}$	7.2	15.2	$\bar{x}$	19.1	21.8
Std. dev.	0.9	1.3	Std. dev.	1.6	2.2	Std. dev.	3.9	4.4
1-4	15	23	1-5	19	27	Control		
2-4	14.	22	2-5	19	32	sites C A	40	33
3-4	16	20	3-5	24	29	C B	30	43
4-4	16	13	4-5	15	17	$\bar{x}$	35	38.0
5-4	17	14	5-5	20	22	Std. dev.	7.1	6.2
6-4	19	15	6-5	19	12			
7-4	23	14	7-5	27	26	Borrow		
8-4	17	16	8-5	23	17	sites B 1	—[1]	15
9-4	21	17	9-5	21	20	B 2	—	11
$\bar{x}$	17.6	17.1	$\bar{x}$	20.8	22.4	$\bar{x}$		13.0
Std. dev.	2.9	3.7	Std. dev.	3.5	6.5	Std. dev.		2.8

[1]No comparable data.

Table 14 presents the dominant species data for borrow sites B1 and B2 for both the November-December and May samplings. Both stations exhibited relatively high levels of oligomixity in November-December with more than 80 percent of fauna represented by only four species (site B1) and three species (site B2). The faunal distribution improved significantly by May with the number of species representing more than 80 percent of the fauna doubling for each site.

Faunal composition between corresponding stations of the nine transects did not vary substantially for either sampling period. Examination of the composite lists and faunal counts (App. B, Tables B-1 and B-2) shows that species numbers varied little between stations. Faunal counts showed some variation between corresponding stations. However, the largest variations were usually due to a greater or lesser abundance of a dominant species. The overall pattern of faunal composition is dominance by several species over all corresponding stations with "rare" species distributed rather uniformly over all stations.

(2) Species Richness. The number of species found at each station is presented in Tables 16 and 17 for November-December and May, respectively. Species richness ranged from 6 to 39 species (stations 7-1 and CB) for November-December and 4 to 43 species (stations 9-1 and CB) for May. Generally, the number of species increased with increasing distance from shore for both sampling periods. Control stations CA and CB exhibited the greatest number of species for both sampling periods. The borrow sites generally had species numbers comparable to stations 2 or 3 of the transects. Overall, there was relatively little variation in species numbers between comparable stations of the nine transects (see Tables 16 and 17).

(3) Faunal Density. For the November-December sampling period faunal density ranged from 192 organisms per square meter at station 1 on transect 4 to 4,912 organisms per square meter at station 4 on transect 8. For May the density ranged from 336 organisms per square meter at station 1 on transect 8 to 6,064 organisms per square meter at station 1 on transect 1. Faunal density estimates for all stations are listed in Tables 18 and 19. Faunal densities for stations 1, 2, 3, CA and CB were generally greatest in May with the exceptions of stations 2-1, 8-1, 9-1, 1-2, 6-3 and 7-3, which exhibited the greatest densities in November-December. Stations 4, 5 and the borrow sites B1, B2 had the highest faunal densities in November-December with the exceptions of stations 2-4, 3-4, 9-4, 2-5, 3-5, and 4-5 having greater numbers in May. Overall, the nearshore stations and CA and CB exhibited greater faunal densities in May than November-December with the offshore stations and borrow sites having greatest densities in November-December. Variation among corresponding stations over the nine transects was largest when the faunal densities were greatest (e.g., variations in faunal density for stations 1, 2 and 3 were largest in May, corresponding to greatest faunal densities).

Table 18. Comparison of faunal density (number of organisms per square meter) between November 1974 and November-December 1979 for all stations.

Station	Faunal density 1974	1979	Station	Faunal density 1974	1979	Station	Faunal density 1974	1979
1-1	224	2,800	1-2	96	992	1-3	1,376	1,088
2-1	112	1,680	2-2	160	976	2-3	1,280	1,568
3-1	64	880	3-2	576	480	3-3	912	1,584
4-1	112	192	4-2	432	576	4-3	1,984	1,776
5-1	160	528	5-2	384	1,408	5-3	3,312	1,808
6-1	224	528	6-2	624	544	6-3	3,664	2,800
7-1	160	416	7-2	336	560	7-3	1,334	3,408
8-1	112	464	8-2	208	960	8-3	2,320	640
9-1	208	912	9-2	352	672	9-3	1,776	1,200
$\bar{x}$	152.9	933.3	$\bar{x}$	352.0	796.4	$\bar{x}$	1,996.4	1,763.6
Std. dev.	57.2	822.4	Std. dev.	178.5	307.2	Std. dev.	946.4	857.9
1-4	576	1,888	1-5	1,392	2,288	Control sites		
2-4	336	1,728	2-5	1,792	1,248			
3-4	1,168	1,488	3-5	768	1,408	C A	2,064	1,408
4-4	1,584	2,624	4-5	1,024	1,008	C B	3,808	4,304
5-4	1,344	1,696	5-5	704	3,360	$\bar{x}$	2,936.0	2,856.0
6-4	2,000	3,072	6-5	1,088	3,232	Std. dev.	1,233.2	2,047.8
7-4	1,936	1,136	7-5	768	2,272			
8-4	976	4,912	8-5	512	2,576	Borrow sites		
9-4	2,336	1,168	9-5	1,360	2,000			
$\bar{x}$	1,361.8	2,190.2	$\bar{x}$	1,045.3	2,154.7	B 1	--[1]	2,244
Std. dev.	670.1	1,202.7	Std. dev.	408.3	832.2	B 2	--	1,520
						$\bar{x}$		1,882.0
						Std. dev.		511.9

[1]No comparable data.

Table 19. Comparison of faunal density (number of organisms per square meter) between May 1975 and May 1980 for all stations.

Station	Faunal density 1975	1980	Station	Faunal density 1975	1980	Station	Faunal density 1975	1980
1-1	21,232	6,064	1-2	1,600	864	1-3	6,112	1,696
2-1	6,880	1,248	2-2	14,000	1,872	2-3	3,264	2,576
3-1	2,048	1,536	3-2	5,424	1,936	3-3	2,816	1,808
4-1	16,272	4,608	4-2	5,728	4,048	4-3	16,016	1,792
5-1	21,440	3,280	5-2	4,976	1,424	5-3	10,912	3,728
6-1	12,224	4,992	6-2	5,456	1,712	6-3	6,096	896
7-1	4,112	1,520	7-2	5,072	1,696	7-3	12,272	1,680
8-1	21,456	336	8-2	4,048	992	8-3	4,512	2,096
9-1	12,480	800	9-2	35,504	2,816	9-3	7,616	1,632
$\bar{x}$	13,127.1	2,709.3	$\bar{x}$	9,089.8	1,930.0	$\bar{x}$	7,735.1	1,989.3
Std. dev.	7,569.1	2,079.7	Std. dev.	10,454.3	977.6	Std. dev.	4,460.4	787.0
1-4	5,776	1,504	1-5	2,240	1,712	Control sites		
2-4	4,000	2,112	2-5	3,632	2,208			
3-4	2,832	1,600	3-5	2,752	2,192	C A	4,784	2,160
4-4	4,080	1,312	4-5	2,640	1,136	C B	5,504	4,560
5-4	2,672	1,104	5-5	3,616	1,856	$\bar{x}$	5,144.0	3,360.0
6-4	2,160	1,208	6-5	2,992	704	Std. dev.	509.1	1,697.1
7-4	3,168	560	7-5	4,176	1,504			
8-4	5,040	1,536	8-5	3,200	976	Borrow sites		
9-4	4,656	1,744	9-5	2,656	1,936			
$\bar{x}$	3,820.4	1,416.9	$\bar{x}$	3,100.4	1,580.4	B 1	--[1]	1,104
Std. dev.	1,203.5	434.1	Std. dev.	612.2	539.0	B 2	--	896
						$\bar{x}$		1,000.0
						Std. dev.		147.0

[1]No comparable data.

(4) Species Diversity and Equitability. Species diversity (Shannon-Weaver H') and equitability values (Pielou's J') are presented in Table 20 (November-December 1979) and Table 21 (May 1980). Diversity values ranged from 0.47 to 3.22 (stations 1-1 and CA) for November-December and 0.15 to 2.85 (stations 1-1 and 2-3) for May. For transect stations 1, 2, and 3 and stations CA and CB, diversity values generally decreased from November-December to May. Transect stations 4 and 5 showed the least amount of seasonal change. Borrow sites B1 and B2 were unusual in exhibiting a pronounced increase in diversity from November-December to May. Diversity values for transect stations 1 and 2 were generally much lower than all other stations, for both sampling periods. Station 4 exhibited lower diversity values than stations 3 or 5.

Equitability values were generally quite high (>0.60) with the exception of transect station 1, indicating a relatively low level of oligomixity within the study area.

Table 22 lists values for Simpson's diversity index (λ) for transect stations 1 to 5 for all nine transects, as well as stations CA and CB and borrow sites B1 and B2. In this case a low λ value indicates a high diversity. This measure shows the trends illustrated in Tables 20 and 21, i.e., stations 1 and 4 have the lowest diversities, with diversity increasing slightly at the offshore stations.

b. Comparison of Faunal Parameters to Saloman's (1976) Study. Comparisons of the species and number of individuals collected for all 47 stations between the present study (1979-80) and Saloman's study (1974-75) are given in Appendix C. The major differences are given below.

(1) Species Richness. For November-December comparisons the number of species collected at each station was greater in 1979 than in 1974, with the exception of station 1-5, with 16 species collected during both studies (Table 16). For May comparisons, 29 stations exhibited more species during 1980, 17 exhibited less, and 1 remained the same (Table 17). The number of species at a station (averaged over 9 transects for stations 1 to 5) is depicted in Figure 9 (November-December) and Figure 10 (May).

(2) Faunal Density. For November-December comparisons faunal densities were mostly greater in 1979 than 1974 (35 stations with faunal densities in 1979 greater than 1974, 12 less than 1974; see Table 18). For May the faunal densities were always higher in 1975 than 1980 (Table 19). This was primarily caused by the extreme abundance of some species in 1975: the bivalve *Donax texasianus* (stations 1 to 4) and the amphipods *Acanthohaustorius sp.* (stations 3, 4, and 5) and *Protohaustorius n.* (stations 3, 4, and 5). Faunal density comparisons for each station (averaged over 9 transects for stations 1 to 5) are exhibited in Figure 9 (November-December) and Figure 10 (May).

Table 20. Comparisons of equitability values (Pielou's J') and Shannon-Weaver diversity values (H') between the November 1974 (Saloman, 1976) sampling and the November-December 1979 collections.

Station	Equitability Pielou's J' 1974	1979	Diversity Shannon-Weaver H' 1974	1979	Station	Equitability Pielou's J' 1974	1979	Diversity Shannon-Weaver H' 1974	1979
1-1	1.00[1]	0.22	0.00	0.47	1-2	0.92	0.64	1.01	1.48
2-1	0.87	0.44	0.96	0.91	2-2	0.96	0.63	1.06	1.31
3-1	0.81	0.64	0.56	1.58	3-2	0.54	0.79	0.75	1.65
4-1	0.73	0.97	0.80	2.14	4-2	0.61	0.87	0.42	1.92
5-1	0.47	0.81	0.33	1.68	5-2	0.98	0.86	0.68	2.07
6-1	0.80	0.75	0.88	1.55	6-2	0.62	0.91	1.10	2.41
7-1	0.88	0.69	0.61	1.23	7-2	0.76	0.80	0.84	1.85
8-1	0.87	0.71	0.96	1.38	8-2	0.39	0.81	0.27	2.13
9-1	0.99	0.66	0.69	1.38	9-2	0.77	0.84	0.54	2.02
$\bar{x}$	0.82	0.65	0.64	1.37	$\bar{x}$	0.73	0.79	0.74	1.87
Std. dev.	0.16	0.22	0.32	0.48	Std. dev.	0.20	0.10	0.29	0.34
1-3	0.69	0.70	1.64	1.80	1-4	0.72	0.65	1.29	1.76
2-3	0.75	0.79	1.93	2.32	2-4	0.76	0.75	1.36	2.26
3-3	0.63	0.81	1.63	2.53	3-4	0.68	0.80	1.80	2.22
4-3	0.76	0.76	1.95	2.14	4-4	0.64	0.52	1.52	1.64
5-3	0.70	0.84	2.02	2.70	5-4	0.62	0.78	1.49	2.29
6-3	0.58	0.57	1.68	1.53	6-4	0.58	0.54	1.22	1.38
7-3	0.71	0.71	1.83	2.37	7-4	0.55	0.90	0.88	2.64
8-3	0.56	0.88	1.43	2.54	8-4	0.58	0.32	1.21	0.96
9-3	0.65	0.80	1.56	2.53	9-4	0.69	0.81	1.65	2.57
$\bar{x}$	0.67	0.76	1.74	2.27	$\bar{x}$	0.65	0.67	1.38	1.97
Std. dev.	0.07	0.09	0.20	0.39	Std. dev.	0.07	0.18	0.27	0.57
1-5	0.67	0.62	1.86	1.75	Control sites				
2-5	0.62	0.83	1.58	2.49	C A	0.71	0.90	1.92	3.22
3-5	0.88	0.81	2.26	2.31	C B	0.58	0.74	1.90	2.71
4-5	0.75	0.84	1.56	2.09	$\bar{x}$	0.65	0.82	1.91	2.97
5-5	0.79	0.64	2.09	1.97	Std. dev.	0.09	0.11	0.01	0.36
6-5	0.66	0.64	1.75	2.17					
7-5	0.82	0.67	1.71	2.04	Borrow sites				
8-5	0.70	0.78	1.26	2.56	B 1	--[2]	0.59	--	1.79
9-5	0.75	0.61	1.45	1.83	B 2	--	0.60	--	1.62
$\bar{x}$	0.74	0.72	1.72	2.13	$\bar{x}$		0.60		1.71
Std. dev.	0.08	0.10	0.31	0.28	Std. dev.		0.01		0.12

[1]Only one species at this station.
[2]No comparable data.

Table 21. Comparisons of equitability values (Pielou's J') and Shannon-Weaver diversity values (H') between the May 1975 sampling (Saloman, 1976) and the May 1980 collections.

Station	Equitability Pielou's J' 1975	1980	Diversity Shannon-Weaver H' 1975	1980	Station	Equitability Pielou's J' 1975	1980	Diversity Shannon-Weaver H' 1975	1980
1-1	0.23	0.10	0.32	0.15	1-2	0.84	0.76	1.36	1.99
2-1	0.52	0.41	0.83	0.80	2-2	0.39	0.67	0.77	1.89
3-1	0.56	0.75	0.78	0.75	3-2	0.29	0.60	0.67	1.70
4-1	0.57	0.27	0.79	0.48	4-2	0.32	0.40	0.58	1.06
5-1	0.50	0.35	0.81	0.63	5-2	0.37	0.68	0.71	1.94
6-1	0.54	0.11	0.76	0.20	6-2	0.54	0.67	1.12	1.85
7-1	0.39	0.42	0.54	0.46	7-2	0.45	0.68	0.87	1.92
8-1	0.57	0.73	1.03	1.31	8-2	0.49	0.71	0.88	1.69
9-1	0.50	0.43	0.90	0.60	9-2	0.20	0.69	0.45	1.86
$\bar{x}$	0.49	0.40	0.75	0.60	$\bar{x}$	0.43	0.65	0.84	1.77
Std. dev.	0.11	0.23	0.21	0.35	Std. dev.	0.19	0.10	0.28	0.28
1-3	0.47	0.74	1.30	2.28	1-4	0.40	0.80	1.09	2.52
2-3	0.67	0.84	1.94	2.85	2-4	0.46	0.65	1.24	2.02
3-3	0.73	0.82	1.99	2.40	3-4	0.55	0.73	1.52	2.18
4-3	0.42	0.82	1.38	2.32	4-4	0.55	0.71	1.52	1.83
5-3	0.38	0.61	1.19	1.95	5-4	0.58	0.58	1.65	1.52
6-3	0.61	0.88	1.84	2.53	6-4	0.62	0.64	1.81	1.73
7-3	0.48	0.77	1.48	2.31	7-4	0.63	0.83	1.96	2.20
8-3	0.58	0.78	1.53	2.58	8-4	0.47	0.57	1.33	1.59
9-3	0.44	0.85	1.28	2.46	9-4	0.55	0.78	1.63	2.20
$\bar{x}$	0.53	0.79	1.55	2.41	$\bar{x}$	0.53	0.70	1.53	1.98
Std. dev.	0.12	0.08	0.30	0.25	Std. dev.	0.08	0.09	0.28	0.33
1-5	0.77	0.70	2.27	2.30	Control sites				
2-5	0.78	0.81	2.23	2.79	C A	0.76	0.78	2.80	2.73
3-5	0.74	0.69	2.35	2.31	C B	0.67	0.68	2.26	2.55
4-5	0.66	0.77	1.79	2.19	$\bar{x}$	0.72	0.73	2.60	2.64
5-5	0.68	0.74	2.03	2.30	Std. dev.	0.06	0.07	0.28	0.13
6-5	0.64	0.84	1.88	2.10					
7-5	0.67	0.83	2.20	2.71	Borrow sites				
8-5	0.72	0.79	2.24	2.22	B 1	--[1]	0.84	--	2.28
9-5	0.67	0.65	2.03	1.95	B 2	--	0.89	--	2.13
$\bar{x}$	0.70	0.76	2.09	2.32	$\bar{x}$		0.87		2.21
Std. dev.	0.50	0.07	0.19	0.27	Std. dev.		0.04		0.11

[1] No comparable data.

Table 22. Comparison of species diversity (Simpson's λ) and faunal similarity (Morisita's Cλ) values.

Station	Simpson's λ				Morisita's Cλ	
	Nov. 1974	Nov.-Dec. 1979	May 1975	May 1980	Nov. 1974-1979	May 1975-1980
1	0.49	0.34	0.48	0.82	0.05	0.82
2	0.53	0.13	0.66	0.17	0.44	0.31
3	0.22	0.13	0.32	0.08	0.51	0.19
4	0.29	0.22	0.30	0.21	0.33	0.22
5	0.18	0.13	0.17	0.13	0.53	0.61
Control sites						
C A	0.20	0.05	0.10	0.11	0.11	0.55
C B	0.33	0.11	0.15	0.16	0.09	0.26
Borrow sites						
B 1	--[1]	0.29	--	0.12		
B 2	--	0.34	--	0.13		
			Borrow and control sites			
			B 1 to B 2		0.39	0.81
			B 1 to C A		0.25	0.66
			B 1 to C B		0.18	0.26
			B 2 to C A		0.27	0.54
			B 2 to C B		0.05	0.18

[1] No comparable data.

(3) Species Composition. An examination of the tables in Appendix C and Tables 13, 14, and 15 shows that there is a great deal of difference between the community composition of 1974-75 and 1979-80. A superficial examination of Tables 13, 14, and 15 indicates that at most of the stations the dominant species have changed. However, a more detailed look at the composite species lists for 1979-80 (see App. B) and the 1974-75 list (Saloman, 1976) indicates that few species were unique to either study. Not evident from the data in these tables is the fact that nearly all the species reported for this study were also reported by Saloman (1976), although not for corresponding sampling periods.

(4) Species Diversity and Equitability. Overall, the species diversity for the 1979-80 data was higher than for the 1974-75 data (Tables 20 and 21). This is because the total number of species collected at most stations was greater in 1979-80. Equitability was also somewhat higher for the present study, although not as marked as species diversity. This indicates that although there were more species collected during the two sampling periods of the present study, the evenness of the species distributions was comparable for both studies.

(5) Faunal Similarity. Morisita's index of faunal similarity was used to compare the 1979-80 and 1974-75 data by station (Table 22). As can be seen, the level of similarity based on the number of species in common and their relative proportions is quite low for all comparisons except station 1 versus 1 for May and borrow site 1 versus 2 for May.

IV. DISCUSSION

1. Study Design Restrictions.

The accuracy of the data collected and the validity of its interpretation are dependent upon the adequacy of the study design. In order to properly assess the environmental impact of the beach nourishment program three components are necessary: (a) quantitative prenourishment base-line information; (b) immediate and short-term impact determinations; and (c) a long-term effects study. Components (a) and (b) have been addressed by other investigators (Saloman, 1976; Saloman, Naughton and Taylor, in preparation, 1982) and component (c) has been addressed by this report. The adequacy of the sampling design used for this study is discussed in Appendix D.

2. General Characterization of Abiotic Parameters.

Values for temperature, salinity, and dissolved oxygen observed in this study can be considered typical for nonestuarine northern Gulf of Mexico waters. The seasonal variations recorded for this study correspond well with those observed by Saloman (1976). Salinity and temperature were essentially uniform throughout the sampling area, and dissolved oxygen varied only slightly. Several rainstorms occurred during sampling, and small changes of salinity and water temperatures were detected at the nearshore stations and surface offshore waters. These variations were generally small and short lived due to the active mixing of waters in the surf and nearshore zones. Saloman, Naughton, and Taylor (in preparation, 1982) noted seasonal fluctuations in salinities that indicated an estuarine influence of St. Andrew Bay on some stations, possibly affecting recruitment in an unpredictable manner. Temperature extremes from winter to summer probably influence community structure by dictating reproductive seasons, but the relatively deep nearshore waters act to dampen rapid changes of water temperature. None of the physical parameters observed in this study could be considered stressful or limiting factors for faunal diversity or abundance within their observed ranges.

The sediments within the study area are very similar alongshore and at comparable distances from shore. Gorsline (1966) comments on the strikingly uniform textures of Florida's west coast, but also notes that there are specific subtle variations in specific parts of the beach. Moreover, these beach zones are periodically altered in response to surf conditions. In view of Gorsline's observations, the differences of grain-size parameters from 1974-75 to 1979-80 (Tables 9 and 10) could be attributed to small changes of exact sample location. The most notable differences in sediment composition were among the percentages of silt-clay, organic carbon, and carbonate. However, due to the extremely low levels of these three components, the differences cannot be considered biologically important and could be attributed to sampling and processing variations. The moderate wave energy of the area, together with the relatively steep-sloping nearshore zone, has resulted in a surface substrata that is almost entirely free of silt-clay sized particles and organic detritus.

3. General Faunal Characterization.

The fauna of the nearshore zone is relatively rich and diverse. The dramatic difference observed in species numbers and faunal densities between corresponding samplings of the two studies (see Figs. 9 and 10) is a function of the normal seasonal variation and not a profound alteration of community composition. The fauna of the area is well represented by the major invertebrate phyla. The following 14 species that were the dominant fauna for 1974-75 were also well represented or dominant during the present study: the polychaetes *Dispio uncinata*, *Magelona riojai*, *Paraonis fulgens*, *Sviolelepis squamata*, *Spio pettiboneae*; the bivalves *Donax texasianus*, *Ervilia concentrica*; the cumacean *Mancocuma* sp.; the amphipods *Acanthohaustorius* n. sp., *Haustorius* n. sp., *Protohaustorius* n. sp., *Pseudohaustorius* n. sp.; the anomuran *Emerita talpoida* and the cephalochordate *Branchiostoma floridae*. Many of the species collected during this and Saloman's (1976) study are new and not yet described in the literature.

Variations of species numbers and faunal densities at corresponding stations of the nine transects were observed, but there were no discernible patterns of distribution. The abundance of dominant species was nearly always the same at corresponding stations varying only in their relative proportions.

The fauna of the control stations CA and CB generally were not similar to the borrow sites B1 and B2. The borrow sites exhibited fewer species and lower faunal densities than the control site, with the exception of November-December when CA had a lower faunal density (Figs. 9 and 10). Patterns of species dominance and relative proportions of dominant species were also different (Table 14). Borrow sites seem to be most similar to transect stations 3 and 5. These differences may be attributed to the long-term effects of dredging (i.e., possible inhibition of recruitment by certain species). It should be noted that stations CA and CB are not totally acceptable controls for comparative purposes due to the large spatial separation and the deeper depths of the control sites (Fig. 1). Also, data from the transect stations have shown that species composition and faunal densities vary with distance from shore. Therefore, dredging effects at the borrow sites are unclear.

4. Sediment-Fauna Relationships.

Substratum type is generally considered the most important factor influencing the distribution of benthic organisms (Peterson, 1913, 1915, 1918; Jones, 1956; Thorson, 1957; Sanders, 1958; McNulty, Work, and Moore, 1962; Buchanan, 1963; Nichols, 1970; Young and Rhoads, 1971; Johnson, 1971; Bloom, Simon, and Hunter, 1972; Collard and D'Asaro, 1973; Pearson, 1975; Probert, 1975; Conner and Simon, 1979).

As a result of the moderate wave energy in the study area, the nearshore sediments experience an almost constant agitation. This agitation is reflected in the type of fauna inhabiting the substratum, most being active burrowers or crawlers capable of reentering the sediments quickly if displaced. There were no species present which require a permanent attachment site and there were few permanent tube dwellers. There were no strong statistical corrrelations between the various sediment parameters (mean grain size, percent silt-clay, organic carbon) and faunal parameters (number of species, faunal density). Physical processes such as wave

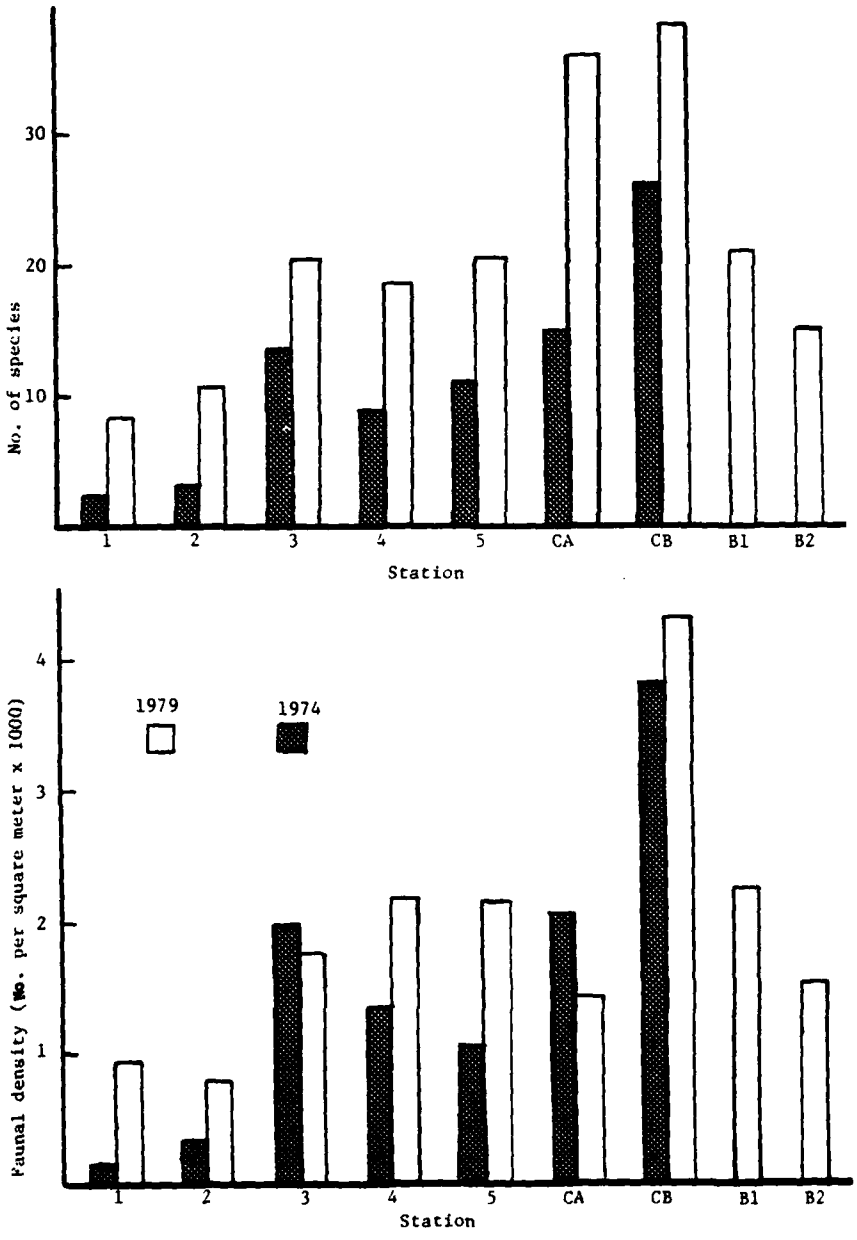

Figure 9. Graphic comparisons of numbers of species and faunal densities between November 1974 and November-December 1979.

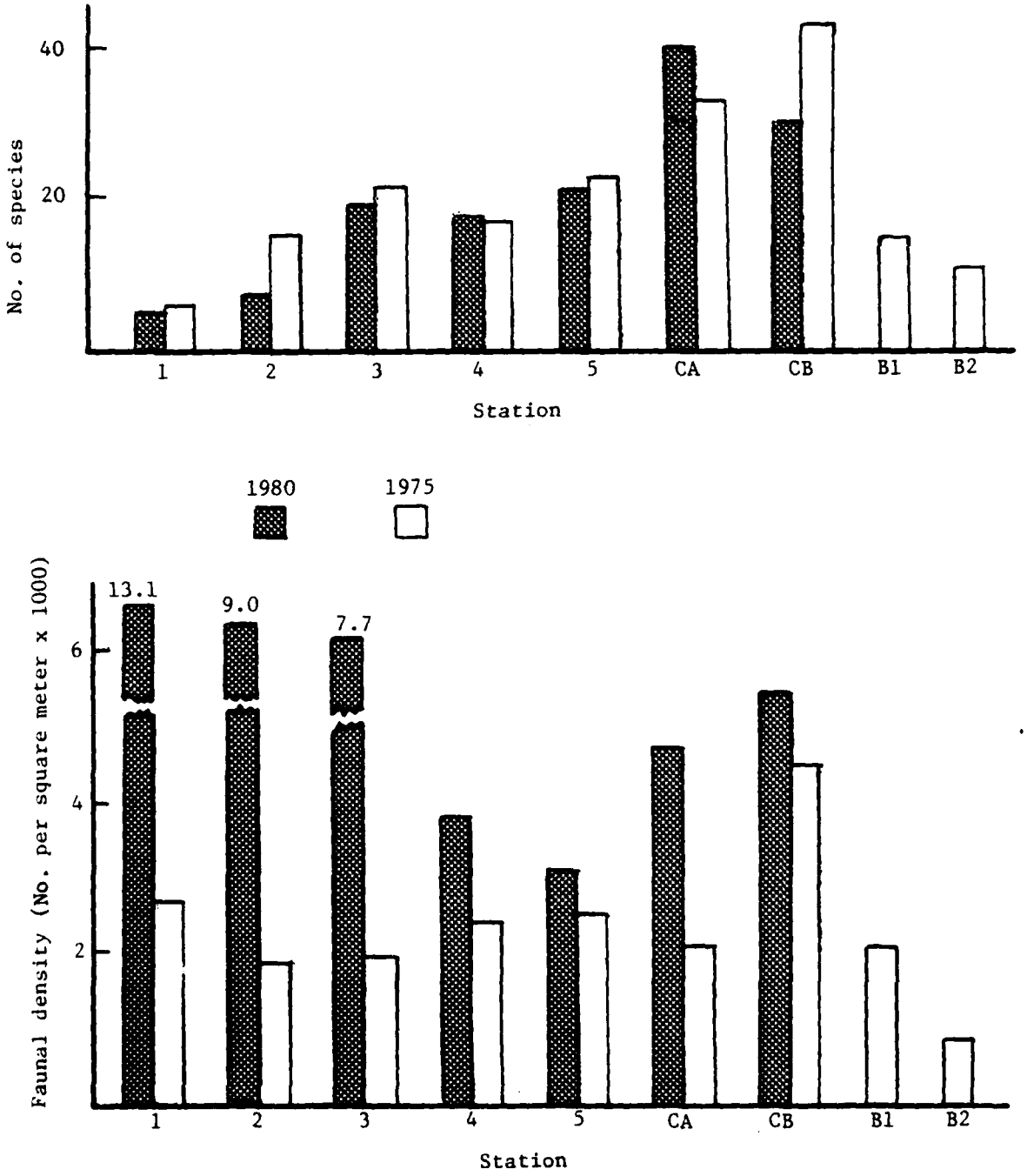

Figure 10. Graphic comparison of numbers of species and faunal densities between May 1975 and May 1980.

energy and longshore currents are probably responsible for the distributional patterns of the nearshore fauna.

5. Comparison of Abiotic and Biotic Parameters Between 1979-80 and 1974-75.

Temperature, salinity, sediment grain-size distribution, organic carbon, and carbonate content showed little variation between 1979-80 and 1974-75. The borrow sites which were not sampled in 1974-75 showed similarities to the control stations for these abiotic parameters. Apparently, the borrow pits initially filled with fine sandy sediments including elevated levels of silt-clay (Saloman, Naughton, and Taylor, in preparation, 1982). However, based on current data the borrow pits have returned to a texture comparable to surrounding areas. Moderate wave action and high longshore transport rates (Balsillie, 1975) probably account for the rapid filling of the borrow pits.

Although community parameters (namely, species richness, faunal density, diversity, and equitability) indicate that most of the stations had a different community composition in 1979-80 than in 1974-75, interpretation of the data considering seasonal and spatial variations indicates that the fauna of the area is drawn from a common pool of "available" species. Therefore, the changes in community composition encountered in this study cannot be attributed to beach nourishment activities. Seasonal variations are known to be significant in most parts of the Gulf of Mexico and adjacent estuarine waters (Livingston, 1976; Livingston, et al., 1976; Simon, 1977; Mahadevan, et al., 1977; Culter, et al., 1981).

6. Long-Term Effects of Beach Nourishment.

Based on the data and findings of this study, it is concluded that the beach nourishment program conducted during 1976 on the Panama City and adjacent beaches has not manifested any long-term discernible effects on the benthic infauna or the surface nearshore sediments.

V. SUMMARY AND CONCLUSIONS

A study of benthic macrofauna and sediments was conducted in the nearshore zone of the area between West Pass and Philips Inlet at Panama City Beach, Florida, in the northeastern Gulf of Mexico. Samples of surface sediments and fauna were collected from 28 November to 1 December 1979 and from 19 to 23 May 1980. Forty-seven stations, located on nine east-west transects, and two dredged borrow sites were sampled.

Temperature, salinity, and dissolved oxygen were measured at each station and found to vary seasonally. There was very little spatial variation of these parameters. Temperature ranged from 16.5° to 26.0° Celsius; salinity ranged from 29.0 to 35.5 parts per thousand; and dissolved oxygen ranged from 4.8 to 8.6 parts per million. Substrata within the study area consisted of fine to medium, coarse quartz sands, with very low levels of silt-clay, percent organic carbon, and percent carbonate. The abiotic parameters collected during this study were similar to Saloman's (1976) measurements. Sediment grain-size parameters were also generally comparable, with the major differences occurring in percentages of silt-clay, organic

carbon and carbonate. These differences are attributable to natural variations as well as sampling and processing variability.

The greatest numbers of species were found in May at the stations seaward of the second sandbar. Faunal density was, on the average, greatest during November-December at stations 4 and 5, with all other stations exhibiting greatest densities during May. The benthic fauna was well represented by the major invertebrate types with polychaetes, crustaceans and bivalves being dominant. The most abundant organisms were generally active burrowing and crawling types. Diversity and equitability values were lowest at stations influenced by wave action (stations 1, surf zone; 2, first sandbar; 4, second sandbar) and highest at stations 3, 5, CA and CB (3, between first and second sandbar; 5, CA and CB beyond second sandbar). Diversity values ranged from 0.15 to 3.22 with the highest values generally occurring in November-December.

The fauna and community parameters of the present study were compared to Saloman's (1976) study. It was determined that the communities of 1979-80 were different from the communities of 1974-75, but that this variation could be attributed to temporal fluctuations.

Borrow sites B1 and B2 were found to have lower species richness and faunal densities than stations CA and CB for both sampling periods, with the exception of station CA, which had a lower faunal density in November-December. The borrow sites also exhibited lower diversity and equitability than stations CA and CB for both sampling periods. Overall, the borrow sites seemed to be most similar to transect stations 3 and 5.

The Morisita's index of faunal similarity was used to compare the station data for the 1979-80 and 1974-75 studies. Only two highly similar comparisons were found: station 1 for the May 1980 collections and borrow sites B1 versus B2 for May 1980.

No long-term adverse environmental effects as a result of beach nourishment could be detected within the nearshore zone of the Panama City beaches. There were also no adverse or stressful conditions present at the borrow sites. These conclusions are based on the analysis of benthic macroinfauna and surface sediment analyses for November-December 1979 and May 1980 and the comparison of these data to Saloman's (1976) study.

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APPENDIX A

PARTICLE-SIZE DISTRIBUTION DATA

Table A-1. Particle-size analysis, percentage composition of one phi size intervals, for the November-December 1979 collections.

Size class	Particle Size (mm)	Phi (Ø) Value	PERCENTAGE COMPOSITION Transects 1-9, Station 1								
			1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1
Gravel	>2.0	<-1	3.56	0.03	0.04	0.04	0.05	0.02	0.00	0.13	0.02
Very coarse sand	1.0	0	2.19	0.20	0.59	0.14	0.90	0.24	0.37	0.54	1.98
Coarse sand	0.5	1	16.45	4.58	10.42	11.10	7.69	9.60	19.02	19.60	22.55
Medium sand	0.25	2	37.89	44.90	54.28	59.57	43.62	54.54	69.67	68.92	60.00
Fine sand	0.125	3	39.57	50.07	34.47	29.07	47.60	35.48	10.87	10.78	15.37
Very fine sand	0.063	4	0.31	0.20	0.18	0.10	0.13	0.14	0.05	0.03	0.07
Silt-clay	<0.063	> 4	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.01
			Transects 1-9, Station 2								
			1-2	2-2	3-2	4-2	5-2	6-2	7-2	8-2	9-2
Gravel	>2.0	<-1	0.06	0.01	0.03	0.00	0.05	0.01	0.00	0.00	0.00
Very coarse sand	1.0	0	0.36	0.13	0.03	0.18	0.38	0.13	0.09	0.10	0.13
Coarse sand	0.5	1	4.64	4.27	0.06	3.09	5.81	1.64	3.17	2.78	1.17
Medium sand	0.25	2	37.18	41.48	32.17	41.48	40.81	34.81	59.22	47.02	37.59
Fine sand	0.125	3	57.45	53.89	67.37	55.01	52.33	62.73	37.44	49.88	60.62
Very fine sand	0.063	4	0.30	0.21	0.34	0.23	0.60	0.63	0.08	0.21	0.49
Silt-clay	<0.063	> 4	0.02	0.01	0.02	0.01	0.01	0.03	0.00	0.00	0.00
			Transects 1-9, Station 3								
			1-3	2-3	3-3	4-3	5-3	6-3	7-3	8-3	9-3
Gravel	>2.0	<-1	0.19	0.01	0.28	0.01	0.10	0.00	0.01	0.08	0.11
Very coarse sand	1.0	0	0.72	0.12	0.34	0.06	0.33	0.03	0.41	1.71	0.22
Coarse sand	0.5	1	6.85	1.23	3.30	1.17	4.21	0.51	7.30	15.26	1.68
Medium sand	0.25	2	26.96	29.28	26.51	14.88	25.86	14.12	47.56	46.77	28.16
Fine sand	0.125	3	64.36	68.65	68.54	81.42	68.41	84.65	44.41	35.99	68.86
Very fine sand	0.063	4	0.92	0.70	1.02	2.46	1.06	0.68	0.28	0.16	0.96
Silt-clay	<0.063	> 4	<0.01	0.01	0.03	0.00	0.01	0.01	0.03	0.02	0.01
			Transects 1-9, Station 4								
			1-4	2-4	3-4	4-4	5-4	6-4	7-4	8-4	9-4
Gravel	>2.0	<-1	0.04	0.02	0.14	0.00	0.01	0.00	0.00	0.22	0.00
Very coarse sand	1.0	0	0.09	0.27	0.14	0.03	0.33	0.10	0.54	0.36	0.21
Coarse sand	0.5	1	0.46	4.42	2.86	0.49	5.27	0.63	4.90	5.35	1.83
Medium sand	0.25	2	.34	26.55	21.82	6.11	22.99	6.18	31.61	32.52	21.45
Fine sand	0.125	3	99.73	67.55	72.78	90.46	70.32	90.25	56.82	60.93	75.23
Very fine sand	0.063	4	3.32	1.44	2.20	2.90	1.07	2.82	6.10	0.59	1.26
Silt-clay	<0.063	> 4	0.02	0.00	0.02	0.01	0.01	0.01	0.04	0.03	0.01
			Transects 1-9, Station 5								
			1-5	2-5	3-5	4-5	5-5	6-5	7-5	8-5	9-5
Gravel	>2.0	<-1	0.18	0.04	0.00	0.01	0.03	0.03	0.00	0.04	0.05
Very coarse sand	1.0	0	0.80	0.17	0.21	0.46	0.21	1.00	0.84	0.27	0.17
Coarse sand	0.5	1	3.93	4.67	1.99	4.74	1.73	6.48	2.52	1.41	0.80
Medium sand	0.25	2	18.21	25.98	17.72	22.92	14.81	12.31	10.68	15.75	8.23
Fine sand	0.125	3	75.52	67.44	78.14	70.72	78.72	75.67	80.94	79.80	83.71
Very fine sand	0.063	4	1.35	1.70	1.92	1.13	4.49	4.48	5.00	2.69	6.98
Silt-clay	<0.063	> 4	<0.01	<0.01	0.01	0.01	0.01	0.03	0.03	0.04	0.05
			Control Sites			Borrow Sites					
			A	B		1	2				
Gravel	>2.0	<-1	<0.01	0.05		0.00	0.04				
Very coarse sand	1.0	0	0.66	0.80		0.03	0.81				
Coarse sand	0.5	1	4.29	5.53		0.64	8.56				
Medium sand	0.25	2	16.85	22.29		5.42	26.04				
Fine sand	0.125	3	72.33	66.47		87.85	62.58				
Very fine sand	0.063	4	5.64	4.80		6.02	1.96				
Silt-clay	<0.063	> 4	0.22	0.06		0.03	0.01				

Table A-2. Particle-size analysis, percentage composition of one phi size intervals, for the May 1980 collections.

Size Class	Particle Size (mm)	Phi (ø) Value	PERCENTAGE COMPOSITION Transects 1-9, Station 1								
			1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1
Gravel	>2.0	<-1	0.37	0.00	<0.01	0.00	0.00	0.00	0.01	0.00	0.00
Very coarse sand	1.0	0	0.89	0.03	0.01	0.03	0.21	0.03	0.36	0.15	0.03
Coarse sand	0.5	1	15.08	0.94	0.89	2.11	0.98	2.86	16.31	17.37	1.90
Medium sand	0.25	2	44.26	27.38	64.62	70.97	57.61	63.02	69.33	70.85	67.72
Fine sand	0.125	3	39.33	71.17	34.43	26.85	41.13	34.00	13.96	11.60	30.29
Very fine sand	0.063	4	0.06	0.46	0.05	0.03	0.07	0.08	0.02	0.02	0.05
Silt-clay	<0.063	> 4	<0.01	0.01	0.01	0.00	<0.01	0.01	<0.01	0.01	0.01
			Transects 1-9, Station 2								
			1-2	2-2	3-2	4-2	5-2	6-2	7-2	8-2	9-2
Gravel	>2.0	<-1	0.10	0.00	0.08	0.02	0.03	0.01	0.00	<0.01	0.00
Very coarse sand	1.0	0	0.57	0.16	0.23	0.04	0.05	0.23	0.04	0.04	0.09
Coarse sand	0.5	1	7.06	1.69	2.60	0.90	1.70	2.33	1.04	0.80	1.11
Medium sand	0.25	2	34.49	19.09	28.60	22.68	30.40	29.42	35.80	25.91	42.08
Fine sand	0.125	3	57.35	78.59	68.02	75.30	67.26	67.24	62.71	72.55	56.35
Very fine sand	0.063	4	0.42	0.44	0.47	1.04	0.54	0.76	0.41	0.69	0.29
Silt-clay	<0.063	> 4	0.01	0.28	0.00	0.02	<0.01	0.01	<0.01	<0.01	0.08
			Transects 1-9, Station 3								
			1-3	2-3	3-3	4-3	5-3	6-3	7-3	8-3	9-3
Gravel	>2.0	<-1	<0.01	0.04	<0.01	0.00	0.01	0.31	0.00	0.38	0.01
Very coarse sand	1.0	0	0.04	0.43	0.07	0.03	0.01	0.18	0.06	0.60	0.09
Coarse sand	0.5	1	0.43	2.50	0.30	0.89	0.37	1.55	0.91	4.69	1.63
Medium sand	0.25	2	5.44	36.70	11.24	26.47	27.46	30.47	20.09	36.88	28.43
Fine sand	0.125	3	91.23	59.93	87.00	71.98	71.69	66.71	76.74	56.59	68.99
Very fine sand	0.063	4	2.85	0.40	1.37	0.63	0.47	0.77	2.18	0.77	0.85
Silt-clay	<0.063	> 4	0.01	<0.01	<0.01	0.01	0.00	0.01	0.02	0.09	0.01
			Transects 1-9, Station 4								
			1-4	2-4	3-4	4-4	5-4	6-4	7-4	8-4	9-4
Gravel	>2.0	<-1	0.25	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00
Very coarse sand	1.0	0	0.56	0.38	0.11	0.02	0.06	0.17	0.61	0.31	0.50
Coarse sand	0.5	1	2.49	6.99	0.91	0.77	1.30	2.24	6.05	4.59	7.41
Medium sand	0.25	2	12.59	23.73	7.70	6.52	19.10	13.46	33.41	41.38	34.78
Fine sand	0.125	3	82.21	66.29	86.67	89.23	77.71	80.63	59.40	52.66	56.46
Very fine sand	0.063	4	1.90	2.61	4.60	3.45	1.83	3.49	0.50	1.05	0.84
Silt-clay	<0.063	> 4	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01
			Transects 1-9, Station 5								
			1-5	2-5	3-5	4-5	5-6	6-5	7-5	8-5	9-5
Gravel	>2.0	<-1	0.01	0.07	0.07	0.00	0.00	0.00	0.00	<0.01	<0.01
Very coarse sand	1.0	0	0.22	0.45	0.34	1.16	0.17	0.23	0.04	0.34	0.18
Coarse sand	0.5	1	1.24	3.18	1.65	15.40	2.15	2.40	0.94	2.65	2.40
Medium sand	0.25	2	12.72	28.00	8.09	27.37	14.65	20.96	10.97	32.49	19.57
Fine sand	0.125	3	81.83	67.26	85.77	55.44	81.48	75.18	85.19	63.60	75.21
Very fine sand	0.063	4	3.98	1.04	3.07	0.62	1.54	1.23	2.82	0.90	2.60
Silt-clay	<0.063	> 4	0.01	0.01	0.02	0.01	<0.01	<0.01	0.05	0.01	0.02
			Control Sites			Borrow Sites					
			A	B		1	2				
Gravel	>2.0	<-1	0.02	0.02		0.00	0.00				
Very coarse sand	1.0	0	1.36	0.63		0.20	0.11				
Coarse sand	0.5	1	8.93	5.26		1.06	1.67				
Medium sand	0.25	2	13.13	21.17		15.89	14.23				
Fine sand	0.125	3	71.43	65.44		81.17	81.89				
Very fine sand	0.063	4	5.11	7.41		1.66	2.09				
Silt-clay	<0.063	> 4	0.03	0.07		0.01	0.01				

APPENDIX B

COMPOSITE SPECIES LIST AND FAUNAL COUNTS

BY STATION

Table B-1. Composite species list and faunal counts for the November-December 1979 sampling.

Species	Station 1 Transect 1	2	3	4	5	6	7	8	9	Station 2 Transect 1	2	3	4	5	6	7	8	9	Station 3 Transect 1	2	3	4	5	6	7	8	9
CNIDARIA																											
HYDROZOA																											
Hydroid sp.							1										1										
ANTHOZOA																											
Anthenaria sp.																										1	
Anemone sp.							1		1																		
CHAETOGNATHA																											
Unidentified sp.					1				1	1	2				1												
PLATYHELMINTHES																											
Turbellaria spp.		6	1	1				1	3													1					
NEMERTINEA																											
Unidentified spp.	1		4	1	1		1			3	2	1					2				1			2	4		1
NEMATODA																											
Unidentified spp.			31			7		7	32	4							6		13						20	3	
GASTROTRICHA																											
Unidentified sp.									5																		
SIPUNCULIDA																											
Sipunculus longipapillosus																											
ANNELIDA																											
OLIGOCHAETA																											
Unidentified spp.	2	9	3						3	10	6		3	13	4										9	1	
POLYCHAETA																											
Apoprionospio pygmaea																									1		
Archiannelida sp.																1	2							1	1		
Aricidea fragilis																									1		
Armandia agilis																											
Armandia maculata																					3	5	1				
Brania clavata																									8	3	1
Brania wellfleetensis																									4		
Dispio uncinata																			1	4	6	3	2	1	5		4
Drilonereis sp. A																											
Glycera americana																											
Glycinde solitaria																											
Lumbrineris parvapedata																											
Magelona riojai																			2		6		6	3		1	2
Melinna maculata																											
Minuspio cirrifera																											
Nephtys bucera															1			1									
Nephtys picta																					1						
Nereis succinea	1																										
Nereis sp.																											
Onuphis e. oculata																					6					1	1
Ophelia sp.																					1						
Paraonis fulgens		1		1				1		35	38		5	12	1	10	11		30	16	15	23	7	86	84	10	26
Phyllodoce arenae																											
Polynoidea sp. A																											1
Prionospio cristata																											
Scoletepis squamata	158	81	8	2	9	14	15	3			1	1	2	2	1	4	3	4		2			6			4	1
Scolopios foliosus																			2	1	2	3	3	4	2	2	4
Scolopios robustus										1		1															
Sigambra bassi																											
Spio pettibonese																				6	7						
Spionid sp. A																											
Spiophanes bombyx																				1	3		3		12	5	1
Polychaeta sp. A																								3	7		
Polychaeta sp. C																									6		
Polychaeta sp. D			1																								
Polychaeta sp. F																											
MOLLUSCA																											
GASTROPODA																											
Anachis pulchella																											
Arene tricarinata											1																
Caecum sp.																											
Cyclostremiscus sp.																	1										
Cylichnella bidentata																											
Nassarius acutus																											
Natica pusilla																				1			1		1		
Oliva sp.																											
Olivella dealbata																											
Olivella mutica																				1	2				1		1
Terebra salleana																											2
Tonnidae sp.																											
Gastropoda sp. C																											
BIVALVIA																											
Cuna dalli						1			1											4			2		17	1	2
Dinocardium robustum																											
Periploma inequale																											
Strigilla sp.					1																						
Tellina versicolor																											
Donax texasianus	2	2	1		2	1	2			1	4	10	12	13	4	1	20	5				1			1	1	1

Table B-1. Composite species list and faunal counts for the November-December 1979 sampling.--Continued

SPECIES	STATION 1 REPLICATE 1	2	3	4	5	6	7	8	9	STATION 2 REPLICATE 1	2	3	4	5	6	7	8	9	STATION 3 REPLICATE 1	2	3	4	5	6	7	8	9
Ervilia concentrica																									1		
Lepton sp.		1																					1		1		
Lucina multilineata																									1		
Macrocallista nimbosa																											1
Pitar simpsoni																									3		
Tellina sp.			1																		1			1			
Strigilla mirabilis																											
Veneridae sp.		1	1									1	1						1	1	2	2		2			2
ARTHROPODA																											
CRUSTACEA																											
COPEPODA																											
Unidentified spp.																1											
CUMACEA																											
Cyclaspis varians																				1							
Nancocuma sp.			1									3	1	2	3	3	5	1									
Oxyurostylis smithi			2																	1							
Unidentified sp. A																											
OSTRACODA																											
Naplocytheride setipunctata																											
Sarsiella sp.																											
Unidentified sp. A																			1				1				
Unidentified sp. B																											
ISOPODA																											
Ancinus depressus																	4								2		2
Chiridotea excavata																					1				1	1	
AMPHIPODA																											
Acanthohaustorius sp.																			9	30	29	40	10	38	14		5
Haustorius n. sp.	1			2	4	1				5	7	10	5	2	2	11	1	7									
Hyperiidea sp.			1	1	3			1						1					3	1	3						
Monoculodes hyei				1															1	6		5	5	1			1
Monoculodes sp.														2	1		1	1			2						
Parahaustorius n. spp.														9	2		1	2					1				
Platyischnopus sp.																											
Protohaustorius n. sp.																				10		7	5	29	2		
Pseudohaustorius n. sp.																							31			2	4
Pseudoplatyischnopus n. spp.																			3		3						
PENAEIDEA																											
Lucifer faxoni										1																	
CARIDEA																											
Agyrides alphaerostris																			1	1			1				
Processa hemphilli																											
Processa sp.																							1				
ANOMURA																											
Albunea peretti																											
Emerita benedicti																											
Emerita talpoida	9	4		1	12	1		1	11							2											
Lepidopa benedicti						1				1								1			1	1					
Paguridae (juv.)																											
Pagurus longicarpus																											
Pagurus sp.																											
BRACHYURA																											
Dissodactylus mellitae																						3	4	1	2		1
Ovalipes floridanus																										1	
Ovalipes ocellatus																											
Persephona mediterreanea																											
Pinnixa chacei																						6	2				
Pinnixa cristata																					1						
Pinnixa retinens													2	12		1		7	1		3	2					
Pinnixa sp.															2								7				
Pinnotheridae sp.																							1				
Xanthidae sp.																											
MYSIDACEA																											
Anchialina typica																											
Bowmaniella brasiliensis																							1				2
Bowmaniella floridana																											
Bowmaniella spp.												3	5	20	8	1	2	12		3		4	1	2	1		7
Metamysidopsis swirti																						3					
Mysid sp.																											
Mysidopsis bahia	1			2		7	6	15																			
Mysidopsis bigelowi																											
Mysidopsis sp. (juv.)															1												
ECHINODERMATA																											
ECHINOIDEA																											
Mellita quinquiesperforata															2					2	1	7	6		3	1	1
HOLOTHUROIDEA																											
Unidentified sp. A																											
OPHIUROIDEA																											
Ophiophragmus wurdemani																											
CEPHALOCHORDATA																											
Branchiostoma floridae																		1			2				1		
Total Number of Individuals	175	105	55	12	33	33	26	29	57	62	61	30	36	88	34	35	60	42	68	38	99	111	113	175	213	40	74
Total Number of Species	8	8	12	9	8	8	6	7	8	10	8	8	9	11	14	10	14	11	13	19	23	17	25	35	28	18	25

Table B-1. Composite species list and faunal counts for the November-December 1979 sampling.--Continued

Species	Station 4, Transect 1	2	3	4	5	6	7	8	9	Station 5, Transect 1	2	3	4	5	6	7	8	9	Controls CA	CB	Borrow Sites B1	B2
CNIDARIA																						
HYDROZOA																						
Hydroid sp.																						
ANTHOZOA																						
Athenaria sp.																						
Anemone sp.																						
CHAETOGNATHA																						
Unidentified sp.																		4				
PLATYHELMINTHES																						
Turbellaria sp.																	1			1		
NEMERTINEA																						
Unidentified sp.	1	3	5	4	4	1	2	4			6	2		1	1	4	2	1		5	1	1
NEMATODA																						
Unidentified sp.		1		1	1		2	1	2						7	12	5	3	6	59		
GASTROTRICHA																						
Unidentified sp.																						
SIPUNCULIDA																						
[illegible]punculus longipapillosus														1								
AN[illegible]																						
[illegible]HAETA																						
Unidentified sp.							2		2	1	9			3	16	4	9	3	4	37		
POLYCHAETA																						
Apoprionospio pygmaea											1	5	3	2								
Archiannelida sp.																						
Aricidea fragilis																			1			
Armandia agilis							1			1	1			2	1	1	2			3	1	
Armandia maculata																	3		1	8		
Brania clavata															3		3		3	1		
Brania wellfleetensis																						
Dispio uncinata	10	16	5		2	2	5	3	2	11	9	4	5	13	1	3	8	5			6	
Drilonereis sp. A									1													
Glycera americana														1								
Glycinde solitaria												1								1		
Lumbrineris parvapedata																			1	1		
Magelona riojai	3	4	6	2	1				1			6					1	1	3	1	2	
Melinna maculata																			1			
Minuspio cirrifera									1							1						
Nephtys bucera																					1	
Nephtys picta	2	1		1			1							1	1	1	1		1	1		
Nereis succinea																						
Nereis sp.	1										1				1				2	2		
Onuphis e. oculata											1				1	3	2	1		1		
Ophelia sp.																						
Paraonis fulgens	6	10	6	102	15	112	8	250	10	11	15	6	18	13	62	42	37	71	3	16	91	
Phyllodoce arenae															2							
Polynoidea sp. A																	1		1	2		
Prionospio cristata															1				1	3		
Scolelepis squamata				3		3			3							1				1	8	
Scoloplos foliosus				1	1	2	1	5	1								1		2		2	
Scoloplos robustus																						
Sigambra bassi																1						
Spio pettiboneae	2													4	12		13	2	1	3		
Spionid sp. A																				2		
Spiophanes bombyx	1	1	1		1		2			1				2	12	1			6	8		
Polychaeta sp. A		1	1		3		4			1												
Polychaeta sp. C																						
Polychaeta sp. D																						
Polychaeta sp. F									1													
MOLLUSCA																						
GASTROPODA																						
Anachis pulchella				1																		
Arene tricarinata																						
Caecum sp.																			1			
Cyclostremiscus sp.																						
Cylichnella bidentata																				1		
Nassarius acutus																				1		
Natica pusilla				1	1		2	1		1	1			1	2	2	2		2	2		
Oliva sp.																	2		3			
Olivella dealbata															1				4	1		
Olivella mutica				1				2							1		2					2
Terebra salleana								2	1													
Tonnidae sp.																			1			
Gastropoda sp. C																1						
BIVALVIA																						
Cuna dalli	1		2									1				1						
Dinocardium robustum																				1		
Periploma inequale																			1			
Strigilla sp.																						
Tellina versicolor										1								2		2		
Donax texasianus												1										

Table B-1. Composite species list and faunal counts for the November-December 1979 sampling.--Continued

SPECIES	STATION 4 TRANSECT 1	2	3	4	5	6	7	8	9	STATION 5 TRANSECT 1	2	3	4	5	6	7	8	9	Controls CA	CB	Borrow Sites A1	A2
Ervilia concentrica												1										
Lepton sp.															1							
Lucina multilineata																	1					
Macrocallista nimbosa																						
Pitar simpsoni																						
Tellina sp.																						
Strigilla mirabilis			1																			
Veneridae sp.				1		2		3	1			1									2	
ARTHROPODA																						
CRUSTACEA																						
COPEPODA																						
Unidentified spp.					1															25		
CUMACEA																						
Cyclaspis varians		1			1			1							2			1				
Nannocuma sp.																						
Oxyurostylis smithi															1							
Unidentified sp. A									1													
OSTRACODA																						
Haplocytherida setipunctata															1				1			
Sarsiella sp.																			1			
Unidentified sp. A																						
Unidentified sp. B				1																		
ISOPODA																						
Ancinus depressus	1																					
Chiridotea excavata													1									
AMPHIPODA																						
Acanthohaustorius sp.	6	24	17	3	33	40	9	15	22	60	7	23	7	37	2	6	22	3	2		1	11
Haustorius n. sp.																						
Hyperiidea sp.		2		1																		
Monoculodes nyei		1	3	3	5				3	3		5						3		5	2	1
Monoculodes sp.	1					5		4			1		1	1	2							
Parahaustorius n. spp.		1	1	6				3	1		1	1		1								
Platyischnopus sp.															2							
Procohaustorius n. sp.	20	4	21	17	12	16	8	1	2	6	7	19	10	37	60	48	27	6	14	16	18	13
Pseudohaustorius n. sp.	59	28	20	2	10				8	40	12	7	5	81	1	2	7	11	4		35	53
Pseudoplatyischnopus n. spp.										2						6	2	1	7	41	1	1
PENAEIDEA																						
Lucifer faxoni															1					1		
CARIDEA																						
Ogyrid sp. *alphaerostris*	2	1			2		10	1	1	2	1	2									2	
Processa hemphilli											1											
Processa sp.																						
ANOMURA																						
Albunea paretii																			1	2		
Emerita benedicti					1		1															
Emerita talpoida													2									
Lepidopa benedicti					1			1	2	1	1				1							2
Paguridae (juv.)																				2		
Pagurus longicarpus		1	1	1		1														1		
Pagurus sp.																			1	1		
BRACHYURA																						
Dissodactylus mellitae				2				2	1				1	2			1	1			1	1
Ovalipes floridanus							1												1	2		1
Ovalipes ocellatus														1								
Persephona mediterranea																			1			
Pinnixa chaeti		3			6			1		1				2								2
Pinnixa cristata																						
Pinnixa retinens																						
Pinnixa sp.																			1			
Pinnotheridae sp.											1										1	1
Xanthidae sp.											2											
MYSIDACEA																						
Anchialina typica																					4	1
Bowmaniella brasiliensis				1																		
Bowmaniella floridana		1																	1			
Bowmaniella spp.		4	3	1		1		3	2			3						1				
Metamysidopsis swifti																						
Mysid sp.																					1	2
Mysidopsis bahia													9									
Mysidopsis bigelowi						2												2				
Mysidopsis sp. (juv.)														1								
ECHINODERMATA																						
ECHINOIDEA																						
Mellita quinquiesperforata				8		5	2	2	1				1	3	1	1	5	4	3	4	1	1
HOLOTHUROIDEA																						
Unidentified sp. A																					1	
OPHIUROIDEA																						
Ophiophragmus wurdemani																				2		
CEPHALOCHORDATA																						
Branchiostoma floridae			1				1		1		1					1	1		1	4		
Total Number of Individuals	118	108	93	164	106	192	71	307	73	143	78	88	63	410	202	142	161	125	88	269	184	94
Total Number of Species	15	20	16	23	19	13	19	20	24	16	20	17	12	22	29	21	26	20	36	39	21	15

Table B-2. Composite species list and faunal counts for the May 1980 sampling.

Species	Station	1									2									3								
	Transect	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
CNIDARIA																												
HYDROZOA																												
Hydroid sp. A									1				1		1	1				1							2	
CHAETOGNATHA																												
Unidentified sp.			1										1			1							1			1	
PLATYHELMINTHES																												
Stylochus sp.																												
NEMERTINEA																												
Unidentified spp.												5			1	2			1	2	2	1	2	4		8	
NEMATODA																												
Unidentified spp.					2				3			3									9					3	
BRYOZOA																												
Unidentified sp.																												
PHORONIDA																												
Phoronis architecta																											10	
OLIGOCHAETA																												
Unidentified spp.											3	2		1						1							1	
POLYCHAETA																												
Apoprionospio pygmaea																								1				
Armandia maculata		•																			2	1		2		2		
Brania wellfleetensis																												
Capitella capitata																											3	
Cauleriella sp.																												
Dispio uncinata												1			1	1			3		6	1	4	4	9	2		3
Eteone heteropoda																												
Eteone lactea																												
Glycera americana																								1	1			
Glycinde solitaria																												
Magelona rioja:											1									7	4	16	5	6		1	1	4
Minuspio cirrifera																												
Myriochele oculata																												
Nephtyidae sp. (juv.)																1												
Nephtys bucera																												
Nephtys picta									1		1	2	4	4	3	5	1	1	1	7	7	6	8	6	2	10	1	3
Nereis sp.																						1			1			
Onuphis eremita oculata																												
Paraprionospio pinnata																												
Paraonis fulgens											12	41	50	14	38	43	49	8	36	33	11	6	23	4	2	5	17	11
Pectinaria gouldii																												
Phyllodoce arenae																										1		
Pista palmata																												
Polydora ligni																												
Polynoidea sp. A																												
Polynoidea sp. B																												
Prionospio cristata																												
Protodorvillea sp.																												
Scoletepis squamata		369	62	79	256	172	301	82	12	42	1	1	2	191	2	1	12	1	12	1		1				1		
Scoloplos foliosus																				1			1			1		
Scoloplos robustus																												
Scoloplos rubra																										1		
Sigambra bassi																								1		1	2	
Spio pettibonege																				4	27	6	10	10	8	8	30	12
Spiophanes bombyx																					1							
Polychaeta sp. G																												
MOLLUSCA																												
GASTROPODA																												
Acteonidae sp. (juv.)																					2						1	
Cylichnella bidentata																										1		
Nitrella lunata																								1				
Nassarius acutus																4					3	3	1		2	1		
Natica pusilla																												
Odostominae sp.														1	1	1												
Oliva sayana																												
Oliva sp.																												
Olivella dealbata																												
Olivella mutica															1					1							1	1
Polinices duplicatus																												
Terebra dislocata																	2	1	2									
Terebra salleana																		1										
Gastropoda sp. (juv.)																	1											
Nudibranch sp. (juv.)																												
BIVALVIA																												
Cuna jelli														1							2						23	
Donax texasianus			8	2	10	19	5	2			7	1	1	13	10	18	8	27	63								1	
Ervilia concentrica																												
Lepton sp.																												
Lucina multilineata																												
Musculus sp.												1																
Pitar simpsoni													1											1				
Solenidae sp.																												
Tellina versicolor													1											1	2			

Table B-2. Composite species list and faunal counts for the May 1980 sampling.--Continued

SPECIES	STATION / TRANSECT	1									2									3								
		1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Tellina sp. (juv.)																												
Veneridae sp.											1										5	2			8		4	3
ARTHROPODA																												
CRUSTACEA																												
COPEPODA																												
Unidentified spp.																			1									
CUMACEA																												
Cyclaspis varians							1												1		1	1					1	
Nancocuma sp.					5						1					1	1			1								
Cumacea sp. A																												
Cumacea sp. B											1																	
Cumacea sp. D																												
Cumacea sp. (frag.)																												
OSTRACODA																												
Haplocytherida setipunctata																												
ISOPODA																												
Ancinus depressus												3					2											
Chiridotea excavata											1	1	2						1	1	1							
Janiropsis sp.										1																		
Idotea sp.					1																							
Idoteidae sp.																											1	
AMPHIPODA																												
Acanthohaustorius sp.		2	5	3	1						19	15	39	14	17	22	12	14	31	7	14	21	13	9	2	3	7	16
Ampelisca sp. B																											2	
Hausturidae sp. (juv.)			1											1							5							
Haustorius n. sp.	5	3	4			1		1	4		5	5		1	3		2		3									
Lembos cf. websteri													1					1									5	
Listriella cf. barnardi																												
Monoculodes nyei												1			1					1								
Monoculodes sp.																						1					1	2
Parahaustorius n. sp.											1	13	9	3	5	1			2		2	1						1
Protohaustorius n. sp.	2																			24	8	24	15	37	1	14		17
Pseudohaustorius n. sp.												1	5			4		2		1		9	5	7	8	13	1	15
Pseudoplatyischnopus n. spp.											1									4	4	3		2		2	2	1
MYSIDACEA																												
Bowmaniella portoricensis																												
Bowmaniella spp.																	1		1	1	1						1	
Metamysidopsis swifti														3														
Mysidopsis sp.													1													1		
Mysidacea sp.																												
PENAEIDEA																												
Lucifer faxoni																	1						1					
CARIDEA																												
Caridea sp.																					2							
Ogyrides alpharostris																								1				
Processa hemphilli																					1							
MACRURA																												
Callianassa sp.													1		1					1	28	8		1	1			3
ANOMURA																												
Albunea paretii																												
Emerita benedicti		1																										
Emerita talpoida	1	1	4	16	6	2	11	3	3					5														
Lepidopa benedicti	2				2	2								1			1											
Paguridae sp.																					1		1			1		
Pagurus longicarpus																				2								
Pagurus sp.												1																1
Scriyilla mirabilis (juv.)																				1	1							
Anomura sp. (juv.)																												
BRACHYURA																												
Dissodactylus mellitae															1						1		2	21	1	4		
Ovalipes floridanus																												
Pinnixa chaei																		4										
Pinnixa chaetopterana																												
Pinnixa cristata																	1											
Pinnixa retinens																								1				
Pinnixa sp.																	1			3								
Pinnotheridae sp. (juv.)													1		1		4		8		6			2			1	4
Portunidae (juv.)				1													1				3				1			
STOMATOPODA																												
Coronis excavatrix																								1	1			
ECHINODERMATA																												
ECHINOIDEA																												
Mellita quinquiespertorata													1		2	1							20	111	2	33		1
CEPHALOCHORDATA																												
Branchiostoma floridae																					1							
Total Number of Individuals		379	78	96	288	205	312	95	21	50	55	117	121	253	89	107	106	62	176	106	161	113	112	233	56	105	131	102
Total Number of Species		5	7	7	6	6	6	3	6	4	14	17	17	14	17	16	17	11	15	22	30	19	17	24	18	20	27	18

Table B-2. Composite species list and faunal counts for the May 1980 sampling.--Continued

Species	Station	4									5									Controls Borrow Sites			
	Transect	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	CA	CB	BI	BC
CNIDARIA																							
HYDROZOA																							
Hydroid sp.											1									1	1		
CHAETOGNATHA																							
Unidentified sp.			1																				
PLATYHELMINTHES																							
Stylochus sp.																1							
NEMERTINEA																							
Unidentified spp.		3		1	2	1		1			4	9	1	3	3		5	1	4	4	4	1	
NEMATODA																							
Unidentified spp.										1	2	2	1		19		1		3	6	5		
BRYOZOA																							
Unidentified sp.												1											
PHORONIDA																							
Phoronis architecta																			1	1	25		
OLIGOCHAETA																							
Unidentified spp.		1		1							2	6			2					1			
POLYCHAETA																							
Apoprionospio pygmaea																					1		
Armandia maculata				1							5	1	3				1		3	1	6		
Brania wellfleetensis											1												
Capitella capitata																					1		
Caulleriella sp.																							
Diopio uncinata		1	5	7	5		1	1		3		1	2	2			2	1	1	2		2	3
Etaone heteropoda																		1					
Etaone lactea													1								1		
Glycera americana			2												1					1			
Glycinde solitaria		8	1	1	1						1	1	3	1						1		2	
Hagelona rioja										1											1		
Minuspio cirrifera										1					1					19			
Myriochele oculata										1					1								
Nephtyidae sp. (juv.)																							
Nephtys bucera		5	5	13	5	4	3		3	11	6	7	11	5	10	6	7	5	6	12	7	4	7
Nephtys picta																					3		
Nereis sp.											1										2		
Onuphis eremita oculata																					2		
Paraprionospio pinnata		23	65	34	35	41	41	11	61	27		16	5	25	32	8	4	13	56	5	7	2	4
Parsonis fulgens												1											
Pectinaria gouldii											1						1				1		
Phyllodoce arenae															1	1							
Pista palmata											1												
Polydora ligni																							
Polynoidea sp. A																				1	1		
Polynoidea sp. B																					1		
Prionospio cristata																					1		
Protodorvillea sp.															1								
Scoletepis squamata		1								2	1		4	1					1				
Scoloplos rolfosus				3			1	1		1													
Scoloplos robustus		1																				1	
Scoloplos rubra																				1			
Sigambra bassi																							
Spio pettibonege											1						1				3		
Spiophanes bombyx		1	1	1	1		1				4	11	9	1	2		6	2		1	6	4	
Polychaeta sp. A																							
MOLLUSCA																							
GASTROPODA																							
Acteonidae sp. (juv.)												1								1	2		
Cylichnella bidentata																					1		
Nitrella lunata																							
Nassarius acutus																							
Natica pusilla													3			1	1	1			4		
Odostomiinae sp.																					1		
Olivella sayana										1													
Olivella sp.																				1			
Turbonilla beebeana												1											
Turbonilla nutica										2	1							2	2		1		
Turbonilles lupinatus																							
Urebra fusiformis																				1			
Terebra salleana																1							
Gastropoda sp. (juv.)																							
Nudibranchia sp. (juv.)																							
BIVALVIA																							
Cuna jaya			1																		1		
Donax texasianus			1			1		2															
Ervilia concentrica																		1		6			
Lepton sp.								1							1								
Lucina multilineata																				1			
Musculus sp.																							
Pitar simpsoni											5							1			98		
Solenidae sp.																					1		
Tellina versicolor			1								1	1	1		1					4		1	1

Table B-2. Composite species list and faunal counts for the May 1980 sampling.--Continued

Species	Station 4 Transect 1	2	3	4	5	6	7	8	9	Station 5 Transect 1	2	3	4	5	6	7	8	9	Controls CA	CB	Borrow Sites B1	B2
Tellina sp. (juv.)																				3		
Veneridae sp.			1			1	1	1								1						
ARTHROPODA																						
CRUSTACEA																						
COPEPODA																						
Unidentified spp.																				1		
CUMACEA																						
Cyclaspis varians																		1	3	4		
Nancocuma sp.											1									1		
Cumacea sp. A													1									
Cumacea sp. B		1			1						2			4		1				1		
Cumacea sp. D						1				1							1					
Cumacea sp. (frag.)																				1		
OSTRACODA																						
Haplocytheride setipunctata																			2	1		
ISOPODA																						
Ancinus depressus	1						2															
Chiridotea excavata	3	9			1	4	1	4	3		1	3	3	1	4	6	9	2	1			2
Ianiropsis sp.																						
Idotea sp.																						
Idoteidae sp.																						
AMPHIPODA																						
Acanthohaustorius sp.	2	4	8	15	6	9	7	8	5	1	2	6		5	7	4		3	1	1	3	11
Ampelisca sp. B																				1		
Haustoridae sp. (juv.)								2				1						1				
Haustorius n. sp.																						
Lembos cf. *websteri*								1														
Listriella cf. *barnardi*								1			1									1		
Monoculodes hyei	1		2			2				2	1								3			
Monoculodes sp.		1		2				1				1		1	1	1		4		10		
Parahaustorius n. sp.	1	3	1	1				1	1		2	2			1							
Protohaustorius n. sp.	16	7	18	11	4	12	1	1	4	49	35	53	14	22	11	25	17	24	36	33	16	9
Pseudohaustorius n. sp.	11	1	2	2				4		1	9	4	4	2	2	10		5		4	13	2
Pseudopleustes schnopus n. spp.						1				7	5	8	3	4		3	2		10	35		
MYSIDACEA																						
Bowmaniella portoricensis												1	2									
Bowmaniella spp.		1	2		4	1		1		1	1		1		1							
Mecamysidopsis swirti																					1	
Mysidopsis sp.																						
Mysidacea sp.								2														
PENAEIDEA																						
Lucifer faxoni																1						
CARIDEA																						
Caridea sp.																						
Ogyrides alphaerostris	1	1	1	1		1					1	1	1	1		1						
Processa hemphilli																						
MACRURA																						
Callianassa sp.	1	5	1		1					1	7	4				1					1	
ANOMURA																						
Albunea paretii																			1			
Emerita benedicti																						
Emerita talpoida																						
Lepidopa benedicti											3					2						
Paguridae sp.			1		1					3	3							1				
Pagurus longicarpus		1							1		1							1				
Pagurus sp.	1											3	3							2		
Strigilla mirabilis (juv.)																12			1			
Anomura sp. (juv.)												1	1									
BRACHYURA																						
Dissodactylus mellitae							1		12							1					4	3
Ovalipes floridanus																			1			
Pinnixa chaeti	3				1							1										
Pinnixa chaetopterana																		1				
Pinnixa cristata																						
Pinnixa retinens																						
Pinnixa sp.																		1				
Pinnotheridae sp. (juv.)	3	12	3	1	1		2	3	9	2	4	2				1		2		1		5
Portunidae (juv.)												1										
STOMATOPODA																						
Coronis excavatrix						1																
ECHINODERMATA																						
ECHINOIDEA																						
Mellita quinquiesperforata							3		25							5		1	4	5	12	12
CEPHALOCHORDATA																						
Branchiostoma floridae	1										1	1		1				1				
Total Number of Individuals	93	132	100	82	69	80	35	96	109	107	138	137	71	116	44	96	61	121	135	284	69	57
Total Number of Species	23	22	20	13	14	15	14	16	17	27	32	29	17	22	12	26	17	20	33	43	15	11

APPENDIX C

COMPARISONS OF THE 1979-80

AND 1974-75 FAUNAL DATA

Table C-1. Comparison of the species and number of individuals collected at the nine transects of station 1 between November 1974 and November-December 1979.

Species	1974 Number Collected	1979 Number Collected
CNIDARIA		
HYDROZOA		
Unidentified sp.	--	1
ANTHOZOA		
Unidentified sp.	--	2
CHAETOGNATHA		
Unidentified sp.	1	2
PLATYHELMINTHES		
Unidentified spp.	--	12
NEMERTINEA		
Unidentified spp.	--	8
NEMATODA		
Unidentified spp.	--	77
GASTROTRICHA		
Unidentified sp.	--	5
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	--	17
POLYCHAETA		
Nereis succinea	--	1
Paraonis fulgens	3	3
Scolelepis squamata	--	290
Unidentified sp. D	--	1
MOLLUSCA		
BIVALVIA		
Cuna dalli	--	2
Donax texasianus	56	10
Lepton sp.	--	1
Strigilla sp.	--	1
Tellina sp.	--	1
Unidentified sp. A	--	1
Veneridae	--	1
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Mancocuma sp.	--	1
Oxyurostylis smithi	--	2
AMPHIPODA		
Hyperiidae sp.	--	6
Haustorius n. sp.	24	8
Monoculodes sp.	--	1
ANOMURA		
Emerita talpoida	3	39
Lepidopa benedicti	--	1
MYSIDACEA		
Mysidopsis bahia	--	31
Total Number of Individuals	87	525
Total Number of Species	5	27

Table C-2. Comparison of the species and number of individuals collected at the nine transects of station 2 between November 1974 and November-December 1979.

Species	1974 Number Collected	1979 Number Collected
CNIDARIA		
HYDROZOA		
Unidentified sp.	--	1
CHAETOGNATHA		
Unidentified sp.	--	4
NEMERTINEA		
Unidentified spp.	3	8
NEMATODA		
Unidentified spp.	--	10
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	--	36
POLYCHAETA		
Nephtys bucera	--	2
Paraonis fulgens	8	112
Scolelepis squamata	--	18
Scoloplos robustua	--	2
ARCHIANNELIDA		
Unidentified sp.	--	3
MOLLUSCA		
BIVALVIA		
Donax texasianus	135	70
Veneridae cf. gouldia	--	2
GASTROPODA		
Cyclostremiscus	--	1
Unidentified sp. A	--	1
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Mancocuma sp.	--	18
ISOPODA		
Ancinus depressus	--	4
AMPHIPODA		
Haustorius n. sp.	48	50
Hyperiidea sp.	--	1
Monoculodes cf. niger	--	6
Parahaustorius n. spp.	--	14
PENAEIDEA		
Lucifer faxoni	--	1
ANOMURA		
Emerita talpoida	2	2
Lepidopa benedicti	--	2
BRACHYURA		
Pinnixa retinens	--	22
Pinnixa sp.	--	2
MYSIDACEA		
Bowmaniella spp.	--	51
Mysidopsis sp.	--	1
COPEPODA		
Unidentified sp.	--	1
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	--	2
CEPHALOCHORDATA		
Branchiostoma floridae	1	1
Total Number of Individuals	197	448
Total Number of Species	6	30

Table C-3. Comparison of the species and number of individuals collected at the nine transects of station 3 between November 1974 and November-December 1979.

Species	1974 Number Collected	1979 Number Collected
CNIDARIA		
ANTHOZOA		
Athenaria sp.	--	1
TURBELLARIA		
Unidentified spp.	--	1
NEMERTINEA		
Unidentified spp.	9	8
NEMATODA		
Unidentified spp.	--	36
OLIGOCHAETA		
Unidentified spp.	--	10
POLYCHAETA		
Apoprionospio pygmaea	--	1
Archiannelida sp.	--	2
Aricidea fragilis	--	1
Armandia maculata	--	9
Branta clavata	--	12
Branta wellfleetensis	--	4
Diopio uncinata	--	26
Magelona riojai	1	20
Nephtys picta	--	1
Onuphis e. oculata	--	8
Ophelia sp.	2	1
Paraonis fulgens	31	297
Polynoidea sp. A	--	1
Prionospio cristata	2	--
Scolelepis squamata	--	13
Scoloplos foliosus	--	23
Spio pettibonege	--	13
Spiophanes bombyx	--	25
Syllides setosa	5	--
Polychaete sp. A	--	10
Polychaete sp. C	--	6
MOLLUSCA		
GASTROPODA		
Natica pusilla	--	1
Oliva sayana	1	--
Olivella mutica	--	5
Terebra salleana	--	2
BIVALVIA		
Chione grus	1	--
Cuna dalli	4	26
Donax texasianus	23	4
Ervilia concentrica	72	1
Lepton sp.	--	1
Lucina multilineata	--	1
Macrocallista nimbosa	--	1
Pitar simpsoni	2	3
Tellina sp. (juv.)	2	--
Veneridae sp.	--	16

Species	1974 Number Collected	1979 Number Collected
CRUSTACEA		
OSTRACODA		
Unidentified sp. A	--	2
CUMACEA		
Cyclaspis varians	--	1
Unidentified sp. A	--	1
ISOPODA		
Ancinus depressus	6	3
Chiridotea excavata	1	3
AMPHIPODA		
Acanthohaustorius sp.	451	175
Haustorius n. sp.	5	--
Hyperiidea sp.	--	7
Monoculodes hyei	--	19
Monoculodes sp.	1	2
Parahaustorius n. spp.	5	1
Protohaustorius n. sp.	68	53
Pseudohaustorius n. sp.	165	37
Pseudoplatyischnopus n. spp.	1	6
Synchelidium sp.	10	--
MYSIDACEA		
Bowmaniella brasiliensis	--	3
Bowmaniella spp.	--	15
Metamysidopsis swifti	--	3
CARIDEA		
Ogyrides alphaerostris	5	3
Processa sp.	--	1
ANOMURA		
Emerita benedicti	1	--
Lepidopa benedicti	--	2
BRACHYURA		
Dissodactylus mellitae	--	11
Ovalipes floridanus	--	1
Pinnixa chaeti	--	8
Pinnixa cristata	--	1
Pinnixa retinens	--	6
Pinnixa sp.	--	7
Pinnotheridae sp.	--	1
SIPUNCULIDA		
Sipunculus longipapillosus	19	
ECHINODERMATA		
OPHIUROIDEA		
Amphipholis squamata	3	--
Unidentified sp. A	1	--
Unidentified sp. B	3	--
ECHINOIDEA		
Mellita quinquiesperforata	22	21
HOLOTHUROIDEA		
Unidentified sp. (juv.)	1	--
HEMICHORDATA		
Unidentified sp. (juv.)	6	--
CEAPHALOCHORDATA		
Branchiostoma floridae	196	3
Total Number of Individuals	1,123	990
Total Number of Species	32	64

Table C-4. Comparison of the species and number of individuals collected at the nine transects of station 4 between November 1974 and November-December 1979.

Species	1974 Number Collected	1979 Number Collected
NEMERTINEA		
Unidentified spp.	4	25
NEMATODA		
Unidentified spp.	10	10
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	2	4
POLYCHAETA		
Armandia maculata	--	3
Branis clavata	--	7
Dispio uncinata	--	50
Drilonereis sp.	--	1
Gyptis vittata	1	--
Magelona riojai	3	17
Minuspio cirrifera	--	1
Nephtys picta	--	5
Nereis sp.	--	1
Ophelia sp.	3	--
Paraonis fulgens	6	519
Prionospio cristata	8	--
Scolelepis squamata	--	9
Scoloplos foliosus	--	11
Spio pettibonese	--	2
Spiophanes bombyx	--	6
Syllides setosa	17	--
Unidentified sp. A	--	9
Unidentified sp. F	--	1
MOLLUSCA		
GASTROPODA		
Anachis pulchella	--	1
Natica pusilla	--	5
Oliva sayana	1	--
Olivella mutica	--	3
Terebra salleana	--	3
BIVALVIA		
Cuna daili	7	3
Donax texasianus	4	--
Ervilia concentrica	2	--
Lepton sp.	1	22
Pitar simpsoni	1	--
Strigilla mirabilis	--	1
Tellina versicolor	1	--
Veneridae sp.	--	7
ARTHROPODA		
CRUSTACEA		
COPEPODA		
Unidentified spp.	--	1
CUMACEA		
Cyclaspis varians	--	3
Unidentified sp. A	--	1
OSTRACODA		
Unidentified sp. B	--	1
ISOPODA		
Ancinus depressus	10	1
Chiridotea excavata	4	--
AMPHIPODA		
Acanthohaustorius sp.	362	169
Haustorius n. sp.	6	--
Hyperiidea sp.	--	3
Monoculodes hyei	--	15
Monoculodes sp.	--	10
Parahaustorius n. spp.	--	12
Protohaustorius n. sp.	35	101
Pseudohaustorius n. sp.	90	127
Synchelidium sp.	1	--
CARIDEA		
Ogyrides alphaerostris	1	17
ANOMURA		
Emerita benedicti	--	2
Emerita talpoida	1	--
Lepidopa benedicti	--	4
Pagurus longicarpus	--	4
BRACHYURA		
Dissodactylus mellitae	--	5
Ovalipes floridanus	--	1
Pinnixa chacei	--	10
MYSIDACEA		
Bowmaniella brasiliensis	--	1
Bowmaniella floridana	--	1
Bowmaniella spp.	--	14
Mysidopsis bigelowi	--	2
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	2	20
OPHIUROIDEA		
Unidentified sp. A	1	--
SIPUNCULIDA		
Sipunculus longipapillosus	4	--
HEMICHORDATA		
Unidentified sp. (juv.)	1	--
CEPHALOCHORDATA		
Branchiostoma floridae	177	3
Total Number of Individuals	766	1,232
Total Number of Species	30	50

Table C-5. Comparison of the species and number of individuals collected at the nine transects of station 5 between November 1974 and November-December 1979.

Species	1974 Number Collected	1979 Number Collected
CHAETOGNATHA		
Unidentified sp.	--	4
NEMERTINEA		
Unidentified spp.	21	17
NEMATODA		
Unidentified spp.	--	27
TURBELLARIA		
Unidentified spp.	--	1
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	1	45
POLYCHAETA		
Apoprionospio pygmaea	--	1
Armandia maculata	--	8
Branta clavata	--	3
Branta wellfleetensis	1	6
Dispio uncinata	--	59
Glycera americana	--	1
Glycinde solitaria	--	1
Magelona riojai	4	8
Minuspio cirrifera	--	1
Nephtys picta	--	4
Nereis sp.	--	2
Onuphis e. oculata	--	8
Ophelia sp.	1	--
Paraonis fulgens	2	275
Pectinaria gouldii	1	--
Phyllodoce arenae	--	2
Phyllodoce sp.	1	--
Polynoidea sp. A	--	1
Prionospio cristata	12	1
Scolelepis squamata	--	1
Scoloplos foliosus	--	1
Sigambra bassi	--	1
Spio pettiboneae	--	31
Spiophanes bombyx	--	16
Unidentified sp. A	--	1
MOLLUSCA		
GASTROPODA		
Natica pusilla	--	9
Oliva sayana	1	--
Oliva sp.	--	2
Olivella desilbata	--	1
Olivella mutica	2	3
Terebra salleana	1	--
Unidentified sp. C	--	1
BIVALVIA		
Cuna delli	1	2
Donax texasianus	2	1
Ervilia concentrica	8	--
Lepton sp.	--	1
Lucina multilineata	--	1
Pitar stimpsoni	--	1
Strigilla mirabilis	8	--
Tellina versicolor	1	2
Veneridae sp.	1	1

Species	1974 Number Collected	1979 Number Collected
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Cyclaspis varians	--	3
Oxyurostylis smithi	--	1
OSTRACODA		
Haplocytherida setipunctata	--	1
ISOPODA		
Ancinus depressus	3	--
Chiridotea excavata	4	1
AMPHIPODA		
Acanthohaustorius sp.	121	167
Haustorius n. sp.	1	--
Monoculodes nyei	4	11
Monoculodes sp.	--	5
Parahaustorius n. spp.	--	3
Platyischnopus sp.	--	2
Protohaustorius n. sp.	80	220
Pseudohaustorius n. sp.	119	165
Pseudoplatyischnopus n. sp. A	--	11
Synchelidium sp.	4	--
PENAEIDAE		
Lucifer faxoni	--	1
CARIDEA		
Ambidexter symmetricus	1	--
Ogyrides alphaerostris	3	5
Processa helphilli	1	1
ANOMURA		
Emerita talpoida	--	2
Lepidopa benedicti	--	3
BRACHYURA		
Dissodactylus mellitae	--	2
Ovalipes ocellatus	--	1
Pinnixa chacei	--	3
Pinnixa cristata	5	--
Pinnotheridae sp.	--	1
Xanthidae sp.	--	2
MYSIDACEA		
Bowmaniella spp.	--	4
Mysidopsis bahia	--	9
Mysidopsis bigelowi	--	2
Mysidopsis sp. (juv.)	--	1
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	8	17
SIPUNCULIDA		
Sipunculus longipapillosus	1	1
HEMICHORDATA		
Unidentified sp. (juv.)	1	--
CEPHALOCHORDATA		
Branchiostoma floridae	160	3
Total Number of Individuals	589	1,212
Total Number of Species	34	68

Table C-6. Comparison of the species and number of individuals collected at the nine transects of station CA between November 1974 and November-December 1979.

Species	1974 Number Collected	1979 Number Collected
NEMERTINEA		
Unidentified spp.	1	--
NEMATODA		
Unidentified spp.	--	6
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	22	4
POLYCHAETA		
Aricidea sp.	2	--
Armandia maculata	5	--
Armandia agilis	--	1
Brania clavata	--	1
Brania wellfleetensis	--	3
Lumbrineris paravapedata	--	1
Magelona riojai	--	3
Melinna maculata	--	1
Nephtys picta	--	1
Nereis sp.	--	2
Onuphis eremita oculata	1	--
Paraonides lyra	19	--
Paraonides sp.	2	--
Paraonis fulgens	--	3
Paraprionospio pinnata	17	--
Polynoidea sp. A	--	1
Prionospio cristata	47	1
Scolelepis sp.	2	--
Scoloplos foliosus	--	2
Spiochaetopterus oculatus	1	--
Spio pettiboneae	7	1
Spiophanes bombyx	--	6
MOLLUSCA		
BIVALVIA		
Periploma inequale	--	1
GASTROPODA		
Caecum sp.	--	1
Natica pusilla	--	2
Olivella dealbata	--	4
Tonnidae sp.	--	1
Oliva sp.	--	3
ARTHROPODA		
CRUSTACEA		
AMPHIPODA		
Acanthohaustorius sp.	--	2
Pseudoplatyischnopus n. spp.	1	7
Protohaustorius n. sp.	--	14
Pseudohaustorius n. sp.	--	4
MYSIDACEA		
Bowmaniella floridana	--	1
OSTRACODA		
Haplocytherida setipunctata	--	1
Sarsiella sp.	--	1
ANOMURA		
Albunea paretii	1	1
Pagurus sp.	--	1
BRACHYURA		
Ovalipes floridanus	--	1
Persephona mediterreanea	--	1
Pinnixa sp. (juv.)	--	1
Portunus spinimanus	1	--
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	--	3
CEPHALOCHORDATA		
Branchiostoma floridae	--	1
Total Number of Individuals	129	88
Total Number of Species	15	36

Table C-7. Comparison of the species and number of individuals collected at the nine transects of station CB between November 1974 and November-December 1979.

Species	1974 Number Collected	1979 Number Collected
NEMERTINEA		
Unidentified spp.	--	5
NEMATODA		
Unidentified spp.	--	59
TURBELLARIA		
Unidentified spp.	--	1
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	18	37
POLYCHAETA		
Aglaophamus verrilli	1	--
Ampharetid sp.	1	--
Aricidea fragilis	1	--
Armandia maculata	11	3
Brania clavata	--	8
Brania wellfleetensis	4	1
Capitellidae unid. sp.	1	--
Glycinde solitaria	--	1
Gyptis vittata	4	--
Heteromastus filliformus	3	--
Lumbrineris paravapedata	--	1
Magelona riojai	--	1
Magelona sp.	1	--
Nephtys picta	--	1
Nereis sp.	--	2
Ophelia sp.	9	--
Onuphis eremita oculata	--	1
Owenia fusiformis	1	--
Paraonides lyra	3	--
Paraonis fulgens	--	16
Paraprionspio pinnata	10	--
Polynoidea sp. A	--	2
Prionospio cristata	134	3
Scolelepis squamata	--	1
Scolelepis sp.	1	--
Spionidae unid. sp.	2	--
Spio pettiboneae	9	3
Spionidae sp. A	--	2
Spiophanes bombyx	--	8
MOLLUSCA		
BIVALVIA		
Tellina versicolor	--	1
Dinocardium robustum	--	1
GASTROPODA		
Cylichnella bidentata	--	1
Nassarius acutus	--	1
Natica pusilla	--	2
Olivella dealbata	--	1
ARTHROPODA		
CRUSTACEA		
AMPHIPODA		
Ampelisca n. sp. A	1	--
Monoculodes nyei	--	5
Protohaustorius n. sp.	--	16
Pseudoplatyischnopus n. spp.	1	41
Synchelidium n. sp.	3	--
COPEPODA		
Unidentified spp.	--	25
ANOMURA		
Albunea paretii	--	2
Pagurus longicarpus	--	1
Pagurus sp.	--	3
PENAEIDEA		
Lucifer taxoni	--	1
Trachypenaeus constrictus	1	--
BRACHYURA		
Ovalipes floridanus	--	2
CARIDEA		
Processa hemphilli	1	--
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	5	4
OPHIUROIDEA		
Ophiophragmus filograneus	1	--
Ophiophragmus wurdemani	--	2
CEPHALOCHORDATA		
Branchiostoma floridae	10	4
Total Number of Individuals	237	269
Total Number of Species	26	38

Table C-8. Comparison of the species and number of individuals collected at the nine transects of station 1 between May 1975 and May 1980.

Species	1975 Number Collected	1980 Number Collected
CNIDARIA		
HYDROZOA		
Hydroid sp.	--	1
CHAETOGNATHA		
Unidentified sp.	--	1
NEMERTINEA		
Unidentified spp.	1	--
NEMATODA		
Unidentified spp.	1	5
ANNELIDA		
POLYCHAETA		
Nephtys picta	--	1
Scolelepis squamata	4,231	1,375
MOLLUSCA		
BIVALVIA		
Donax texasianus	2,827	46
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Cyclaspis varians	--	1
Mancocuma n. sp.	16	5
ISOPODA		
Ianiropsis sp.	--	1
Idotea sp.	--	1
AMPHIPODA		
Acanthohaustorius n. sp.	--	1
Haustoridae sp. (juv.)	--	1
Haustorius n. sp.	88	18
Protohaustorius n. sp.	--	2
ANOMURA		
Emerita benedicti	--	1
Emerita talpoida	218	47
Lepidopa benedicti	1	6
BRACHYURA		
Pinnixa cristata	1	--
Portunidae (juv.)	--	1
Total Number of Individuals	7,384	1,524
Total Number of Species	9	18

Table C-9. Comparison of species and number of individuals collected at the nine transects of station 2 between May 1975 and May 1980.

Species	1975 Number Collected	1980 Number Collected
CNIDARIA		
HYDROZOA		
Hydroid sp.	--	3
CHAETOGNATHA		
Unidentified sp.	--	2
NEMERTINEA		
Unidentified spp.	7	9
NEMATODA		
Unidentified spp.	2	3
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	--	6
POLYCHAETA		
Dispio uncinata	--	6
Magelona riojai	--	1
Nephtyid sp.		--
Nephtys bucera		1
Nephtys picta	--	22
Paraonis fulgens	53	291
Scolelepis squamata	289	223
MOLLUSCA		
GASTROPODA		
Hastula salleana	2	--
Natica pusilla	--	4
Oliva sayana	--	3
Polinices duplicatus	--	1
Terebra salleana	--	5
Gastropoda sp. (juv.)	--	1
Nudibranch sp. (juv.)	--	1
BIVALVIA		
Cuna dalli	--	1
Donax texasianus	4,134	148
Musculus sp.	--	1
Pitar simpsoni	--	1
Tellina versicolor	--	1
Veneridae sp.	--	1
ARTHROPODA		
CRUSTACEA		
COPEPODA		
Unidentified spp.	--	1
CUMACEA		
Cyclaspis varians	--	1
Mancocuma n. sp.	294	9
Cumacea sp. B	--	1
ISOPODA		
Ancinus depressus	10	5
Chiridotea excavata	--	5
AMPHIPODA		
Acanthohaustorius sp.	--	203
Haustoridae sp. (juv.)	--	1
Haustorius n. sp.	284	29
Lembos cf. websteri	--	2
Monoculodes nyei	--	2
Parahaustorius n. spp.	6	34
Protohaustorius n. sp.	--	2
Pseudohaustorius n. sp.	2	12
Pseudoplatyischnopus n. spp.	--	1
MYSIDACEA		
Bowmaniella spp.	--	2
Metamysidopsis swifti	--	3
Mysidopsis sp.	--	1
PENAEIDEA		
Lucifer faxoni	--	1
MACRURA		
Callianassa sp.	--	2
ANOMURA		
Emerita talpoida	16	5
Lepidopa benedicti	1	2
Pagurus sp.	--	1
BRACHYURA		
Dissodactylus mellitae	--	1
Pinnixa chacei	--	4
Pinnixa cristata	11	1
Pinnixa sp	--	1
Pinnotheridae sp. (juv.)	--	14
Portunidae (juv.)	--	1
ECHINODERMATA		
ECHINODEA		
Mellita quinquiesperforata	--	4
Total Number of Individuals	5,113	1,086
Total Number of Species	16	53

Table C-10. Comparison of the species and number of individuals collected at the nine transects of station 3 between May 1975 and May 1980.

Species	1975 Number Collected	1980 Number Collected
CNIDARIA		
HYDROZOA		
Hydroid sp.	--	1
CHAETOGNATHA		
Unidentified sp.	--	2
NEMERTINEA		
Unidentified spp.	24	24
NEMATODA		
Unidentified spp.	2	12
PHORONIDA		
Phoronis architecta	--	10
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	1	2
POLYCHAETA		
Apoprionospio pygmaea	--	1
Armandia maculata	1	7
Capitella capitata	--	3
Dispio uncinata	15	29
Eteone heteropoda	1	--
Glycera americana	--	2
Magelona riojai	25	44
Micronephtys minuta	2	--
Nephtys bucera	7	--
Nephtys picta	--	50
Nereis sp.	--	2
Paraonis fulgens	15	112
Phyllodoce arenae	--	1
Podarmus sp.	--	2
Scolelepis squamata	--	2
Scoloplos foliosus	--	3
Sigambra bassi	--	1
Spionid sp.	1	--
Spio pettibonnae	224	4
Spiophanes bombyx	19	115
Polychaete sp. G	--	1
MOLLUSCA		
GASTROPODA		
Acteonidae sp. (juv.)	--	3
Mitrella lunata	--	1
Nassarius acutus	--	1
Natica pusilla	--	10
Olivella mutica	1	--
Polinices duplicatus	--	3
BIVALVIA		
Cuna dalli	5	25
Donax texasianus	2,210	1
Ervilia concentrica	8	--
Pitar simpsoni	--	1
Tellina versicolor	--	3
Veneridae sp.	12	22

Species	1975 Number Collected	1980 Number Collected
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Cyclaspis varians	--	3
Nancocuma n. sp.	2	1
ISOPODA		
Ancinus depressus	2	--
Chiridotea excavata	2	2
Idoteidae sp.	--	1
AMPHIPODA		
Acanthohaustorius n. sp.	1,016	92
Ampelisca sp. B	--	2
Caprellidae sp. A	2	--
Haustoridae sp. (juv.)	--	5
Haustorius n. sp.	5	--
Lembos cf. websteri	--	5
Monoculodes nyei	2	1
Parahaustorius n. spp.	6	4
Protohaustorius n. sp.	397	140
Pseudohaustorius n. sp.	105	59
Pseudoplatyischnopus n. spp.	--	18
Synchelidium n. sp.	23	--
MYSIDACEA		
Bowmaniella spp.	--	3
Mysidopsis sp.	--	1
PENAEIDEA		
Lucifer faxoni	--	1
CARIDEA		
Caridea sp.	--	2
Ogyrides alphaerostris	47	1
Processa hemphilli	4	1
MACRURA		
Callianassa sp.	36	42
ANOMURA		
Lepidopa benedicti	2	1
Pagurus longicarpus	5	3
Pagurus sp.	--	2
Paguridae sp.	--	3
BRACHYURA		
Dissodactylus mellitae	2	29
Pinnixa cristata	13	--
Pinnixa retinens	--	1
Pinnotheres maculatus	10	--
Pinnotheridae sp. (juv.)	--	13
Portunus gibbesii	4	--
Portunidae sp. (juv.)	--	4
STOMATOPODA		
Coronis excavatrix	8	2
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	71	167
HOLOTHUROIDEA		
Unidentified sp. (juv.)	3	--
HEMICHORDATA		
Unidentified sp. (juv.)	2	--
CEPHALOCHORDATA		
Branchiostoma floridae	1	1
PISCES		
Unidentified ophidiid	1	--
Total Number of Individuals	4,352	1,110
Total Number of Species	45	63

Table C-11. Comparison of the species and number of individuals collected at the nine transects of station 4 between May 1975 and May 1980.

Species	1975 Number Collected	1980 Number Collected
PLATYHELMINTHES		
TURBELLARIA		
Unidentified spp.	1	--
CHAETOGNATHA		
Unidentified sp.	--	1
NEMERTINEA		
Unidentified spp.	18	8
NEMATODA		
Unidentified spp.	1	1
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	--	2
POLYCHAETA		
Armandia maculata	1	1
Dispio uncinata	15	26
Glycinde solitaria	--	2
Magelona obockensis	2	--
Magelona riojai	10	11
Micronephtys minuta	1	--
Micronephtys sp.	1	--
Minuspio cirrifera	--	1
Myriochele oculata	--	2
Nephtys bucera	4	--
Nephtys picta	--	49
Paraonis fulgens	77	338
Prionospio cristata	1	--
Scolelepis squamata	17	3
Scoloplos foliosus	1	4
Scoloplos robustus	--	1
Spionid sp.	1	--
Spio pettibonese	19	--
Spiophanes bombyx	4	5
MOLLUSCA		
GASTROPODA		
Oliva sayana	--	1
Oliva mutica	--	2
Polinices duplicatus	1	--
BIVALVIA		
Cuna dalli	--	1
Donax texasianus	818	4
Ervilia concentrica	2	--
Lepton sp.	--	1
Strigilla mirabilis	4	--
Tellina versicolor	--	1
Unid. venerid (nr. *Gouldia*)	2	--
Veneridae sp.	--	4
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Mancocuma sp.	3	--
Unidentified sp.	1	--
Cumacea sp. B	--	2
Cumacea sp. D	--	1
ISOPODA		
Ancinus depressus	27	3
Chiridotea excavata	8	25
AMPHIPODA		
Acanthohaustorius sp.	821	64
Haustoridae sp. (juv.)	--	2
Haustorius n. sp.	4	--
Lembos cf. websteri	--	1
Listriella cf. barnardi	--	1
Monoculodes hyi	2	5
Monoculodes sp.	--	4
Parahaustorius n. spp.	13	8
Protohaustorius n. sp.	160	74
Pseudohaustorius n. sp.	30	20
Pseudoplatyischnopus n. spp.	--	6
Synchelidium n. sp.	15	--
MYSIDACEA		
Bowmaniella spp.	--	9
Metamysidopsis swifti	--	2
Mysidacea sp.	--	2
CARIDEA		
Ogyrides alphaerostris	7	5
Processa vicina	1	--
MACRURA		
Callianassa sp.	--	8
Unidentified sp.	11	--
ANOMURA		
Emerita talpoida	6	--
Paguridae sp.	--	2
Pagurus longicarpus	1	2
Pagurus sp.	--	1
BRACHYURA		
Dissodactylus mellitdae	--	13
Ovalipes ocellatus	1	--
Pinnixa chacei	--	4
Pinnixa cristata	13	--
Pinnotheres maculatus	3	--
Pinnotheridae sp. (juv.)	--	34
Portunus gibbesii	4	--
STOMATOPODA		
Coronis excavatrix	--	1
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	10	28
HOLOTHUROIDEA		
Unidentified sp. (juv.)	5	--
HEMICHORDATA		
Unidentified sp. (juv.)	1	--
CEPHALOCHORDATA		
Branchiostoma floridae	1	1
Total Number of Individuals	2,149	797
Total Number of Species	46	51

Table C-12. Comparison of the species and number of individuals collected at the nine transects of station 5 between May 1975 and May 1980.

Species	1975 Number Collected	1980 Number Collected
CNIDARIA		
Hydrozoa sp.	--	1
PLATYHELMINTHES		
TURBELLARIS		
Stylochus sp.	--	1
Unidentified spp	1	--
NEMERTINEA		
Unidentified spp.	41	29
NEMATODA		
Unidentified spp.	5	28
BRYOZOA		
Unidentified sp.	--	1
PHORONIDA		
Phoronis architecta	--	1
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	1	10
POLYCHAETA		
Apoprionospio pygmaea	1	--
Armandia maculata	5	14
Brania wellfleetensis	--	1
Diopatra cuprea	8	9
Eteone heteropoda	--	1
Eteone lactea	--	1
Glycera americana	--	1
Glycera oxycephala	1	--
Glycinde solitaria	--	1
Hageiona pinjai	56	5
Micronephtys minuta	2	--
Myriochele oculata	--	1
Nephtyidae sp. (juv.)	--	1
Nephtys bucera	12	--
Nephtys picta	3	63
Onuphis eremita oculata	--	1
Paraonis fulgens	30	159
Pectinaria gouldii	--	1
Phyllodoce arenae	--	1
Pista palmata	--	1
Polydora ligni	--	1
Protodorvillea sp.	--	1
Scoletepis squamata	1	1
Scoletepis texana	1	--
Spio pettiboneae	212	2
Spiophanes bombyx	31	35
Syllides stetosa	1	--
MOLLUSCA		
GASTROPODA		
Acteonidae sp. (juv.)	--	1
Natica pusilla	--	6
Olivella dealbata	--	1
Olivella mutica	--	1
Oliva sayana	1	--
Polinices duplicatus	2	--
Terebra salleana	--	1
BIVALVIA		
Donax texasianus	3	--
Ervilia concentrica	30	1
Lepton sp.	1	1
Pitar simpsoni	--	6
Strigilla mirabilis	4	--
Tellina versicolor	1	1
Unid. Veneridae (nr. *Gouldia*)	1	--
Veneridae sp.	--	1
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Cyclaspis varians	3	1
Mancocuma n. sp.	--	1
Cumacea sp. A	--	1
Cumacea sp. B	--	1
Cumacea sp. D	--	2
Unidentified sp.	2	--
ISOPODA		
Chiridotea excavata	20	29
AMPHIPODA		
Acanthonaustorius sp.	496	28
Haustoridae sp. (juv.)	--	2
Listriella cf. *barnardi*	--	1
Monoculodes hyei	13	3
Monoculodes sp.	--	8
Parahaustorius n. spp.	--	5
Protohaustorius n. sp.	432	250
Pseudohaustorius n. sp.	107	37
Pseudoplatyischnopus n. spp.	6	32
Syncheilidium n. sp.	30	--
Tiron sp.	1	--
MYSIDACEA		
Bowmaniella portoricensis	--	3
Bowmaniella spp.	--	4
PENAEIDEA		
Lucifer faxoni	--	1
CARIDEA		
Hyprides xiphaerostris	--	5
Processa hemphilli	21	--
MACRURA		
Callianassa sp.	--	13
Unidentified sp.	6	--
ANOMURA		
Lepidopa benedicti	3	5
Paguridae sp.	--	1
Pagurus longicarpus	10	2
Pagurus sp.	--	6
Strigilla mirabilis (juv.)	--	2
Anomura sp. (juv.)	--	1
BRACHYURA		
Dissodactylus mellitae	--	1
Ovalipes ocellatus	1	--
Pinnixa chacei	--	1
Pinnixa chaetopterana	--	1
Pinnixa cristata	9	--
Pinnixa maculatus	2	--
Pinnixa sp.	--	1
Pinnotheridae sp. (juv.)	--	11
Portunidae (juv.)	--	1
Portunus gibbesii	5	--
Unidentified xanthid	1	--
ECHINODERMATA		
ASTEROIDEA		
Astropecten articulatus	1	--
ECHINOIDEA		
Mellita quinquiesperforata	9	6
CEPHALOCHORDATA		
Branchiostoma floridae	41	4
PISCES		
Unidentified ophiidid	1	
Total Number of Individuals	1,715	889
Total Number of Species	49	72

Table C-13. Comparison of the species and number of individuals collected at the nine transects of station CA between May 1975 and May 1980.

Species	1975 Number Collected	1980 Number Collected
CNIDARIA		
HYDROZOA		
Hydroid sp.	--	1
PLATYHELMINTHES		
TURBELLARIA		
Unidentified spp.	4	--
NEMERTINEA		
Unidentified spp.	7	4
NEMATODA		
Unidentified spp.	7	6
PHORONIDA		
Phoronis architecta	--	1
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	5	1
POLYCHAETA		
Apoprionospio pygmaea	1	--
Armandia maculata	18	1
Brania wellfleetensis	2	--
Dispio uncinata	--	2
Eteone heteropoda	1	--
Glycera americana	--	1
Glycera oxycephala	1	--
Magelona riojai	1	1
Magelona sp.	1	--
Mesochaetopterus sp.	1	--
Myriochele oculata	--	19
Nephtys picta	7	12
Paraprionospio pinnata	3	--
Paraonis fulgens	--	5
Phyllodoce arenae	4	--
Phyllodoce sp.	5	--
Poecilochaetus johnsoni	1	--
Polynoidea sp. A	--	1
Prionospio cirrifera	1	--
Prionospio cristata	4	--
Scolelepis texana	5	--
Scoloplos rubra	--	1
Sigambra bassi	1	--
Spio pettiboneae	9	--
Spiophanes bombyx	42	1
MOLLUSCA		
GASTROPODA		
Acteonidae sp. (juv.)	--	1
Oliva sp.	--	1
Polinices duplicatus	2	--
Terebra dislocata	1	1
BIVALVIA		
Ervilia concentrica	1	6
Lucina multilineata	2	1
Stringilla mirabilis	2	--
Tellina versicolor	1	4
ARTHROPODA		
CRUSTACEA		
CUMACEA		
Cyclaspis varians	--	3
Oxyurostylis smithi	3	--
OSTRACODA		
Haplocytherida setipunctata	--	2
ISOPODA		
Chiridotea excavata	--	1
AMPHIPODA		
Acanthohaustorius sp.	8	1
Lysianopsis sp.	1	--
Monoculodes nyei	--	3
Protohaustorius n. sp.	58	36
Pseudohaustorius n. sp.	4	--
Pseudoplatyischnopus n. spp.	2	10
Synchelidium n. sp.	3	--
CARIDEA		
Processa hemphilli	7	--
ANOMURA		
Albunea paretii	--	1
Strigilla mirabilis (juv.)	--	1
BRACHYURA		
Ovalipes floridanus	--	1
Pinnotheres maculatus	2	--
Pinnotheridae sp. (juv.)	--	1
ECHINOIDEA		
Mellita quinquiesperforata	--	4
Unidentified sp. (juv.)	11	--
CEPHALOCHORDATA		
Branchiostoma floridae	59	--
PISCES		
Unidentified ophidiid	1	--
Total Number of Individuals	299	135
Total Number of Species	41	33

Table C-14. Comparison of the species and number of individuals collected at the nine transects of station CB between May 1975 and May 1980.

Species	1975 Number Collected	1980 Number Collected
CNIDARIA		
HYDROZOA		
Hydroid sp.	--	1
PLATTHELMINTHES		
TURBELLARIA		
Unidentified spp.	2	--
NEMERTINEA		
Unidentified spp.	6	4
NEMATODA		
Unidentified spp.	12	5
PHORONIDA		
Phoronis architecta	--	25
ANNELIDA		
OLIGOCHAETA		
Unidentified spp.	1	--
POLYCHAETA		
Anaitides erythrophyllus	1	--
Apoprionospio pygmaea	2	1
Armandia maculata	24	6
Brania wellfleetensis	1	--
Caulleriella sp.	--	1
Eteone heteropoda	1	--
Eteone lactea	--	1
Micronephtys minuta	2	--
Minuspio cirrifera	--	1
Nephtys bucera	1	--
Nephtys picta	4	7
Nereis sp.	--	3
Onuphis eremita oculata	--	2
Paraprionospio pinnata	--	2
Phyllodoce arenae	2	1
Phyllodoce sp.	2	--
Polynoidea sp. A	--	1
Polynoidea sp. B	--	1
Prionospio cristata	3	1
Scoletepis texana	11	--
Spio pettibonese	22	3
Spiophanes bombyx	29	6
MOLLUSCA		
GASTROPODA		
Acteonidae sp. (juv.)	--	2
Cylichnella bidentata	--	1
Natica pusilla	--	4
Odostominae	--	1
Olivella mutica	--	1

Species	1975 Number Collected	1980 Number Collected
BIVALVIA		
Cuna dalli	--	1
Ervilia concentrica	2	--
Pitar simpsoni	--	98
Solenidae sp.	--	1
Strigilla mirabilis	7	--
Tellina sp. (juv.)	--	3
ARTHROPODA		
CRUSTACEA		
COPEPODA		
Unidentified spp.	--	1
CUMACEA		
Cyclaspis varians	--	4
Mancocuma n. sp.	--	1
Cumacea sp. B	--	1
Cumacea sp. (frag.)	--	2
OSTRACODA		
Haplocytherida setipunctata	--	1
AMPHIPODA		
Acanthohaustorius sp.	16	1
Ampeliscа sp. B	--	1
Listriella cf. *barnardi*	--	1
Monoculodes hyei	--	10
Protohaustorius n. sp.	100	33
Pseudohaustorius n. sp.	1	4
Pseudoplatyischnopus n. spp	3	35
Synchelidium n. sp.	6	--
CARIDEA		
Processa humphilli	1	
ANOMURA		
Pagurus sp.		1
BRACHYURA		
Pinnixa cristata	1	
ECHINODERMATA		
ECHINOIDEA		
Mellita quinquiesperforata	--	5
Unidentified sp (juv.)	7	-
CEPHALOCHORDATA		
Branchiostoma floridae	74	-
Total Number of Individuals	366	284
Total Number of Species	29	41

APPENDIX D

STUDY DESIGN RESTRICTIONS

APPENDIX D

STUDY DESIGN RESTRICTIONS

The primary purpose of this study was to collect data on the benthic macroinfauna and the surface sediments to evaluate the long-term effects of beach nourishment and associated dredging activities. Inherent in any environmental study are limitations on the quantity and types of data that can be collected. A good study plan requires that the data collected enable the investigators to differentiate between manmade and natural perturbations. If no effects can be detected, then by definition there has been no environmental harm. This emphasizes the need to conduct scientifically valid studies utilizing best applicable methodologies. Potential limiting factors encountered in this study are discussed below.

Sampling Design Adequacy.

The accuracy of the data collected for the present study and the validity of the interpretations and comparisons made to the base-line study (Saloman, 1976) are dependent on the adequacy of the sampling design. Some of the key factors in establishing sampling and analysis adequacy are:

(a) Reliability and accuracy of sampling device (consistent substrate penetration, no loss of sample during retrieval, etc.). Characteristics for a good sampling device are described by Menzies and Rowe (1968) and Holme and McIntyre (1971).

(b) Adequate sieve size to retain a majority of the macrofauna (Reish, 1959).

(c) Good and consistent procedures to ensure proper preservation of fauna.

(d) Adequate number of stations to determine spatial varability of fauna.

(e) Sufficient replication to adequately describe both the within-station faunal variation, and the majority of the species inhabiting the site.

(f) Sufficient temporal frequency of sampling to address seasonal variations in fauna.

(g) The use of identical or comparable methodologies for both prenourishment and postnourishment studies.

(h) Sound taxonomic procedures and use of expert confirmations to ensure accurate identification of organisms.

(i) Consistent data analysis procedures.

The present study addressed the above criteria as follows to ensure the collection of an adequate, quantitative data base:

(a) A diver-operated core was utilized to ensure consistent penetration and the collection of samples satisfying the criteria defined by Menzies and Rowe (1968). The core is generally considered a better device than conventional grabs (Word, Kauwling, and Mearns, 1976; Swartz, 1978).

(b) A 0.701-millimeter mesh sieve was utilized to wash the samples. This sieve size was considered by Saloman (personal communication, 1979) to be adequate for collecting a majority of the macrofauna within the study area. Other studies have shown that a 0.5-millimeter mesh sieve is often necessary for quantitative benthic collections (Reish, 1959; Mahadevan and Patton, 1979). A quantitative comparison of the two sieve sizes for the study area would be necessary to compare the results with other studies that used the smaller mesh size.

(c) Fixing and preserving methods were consistent and followed acceptable procedures in the literature.

(d) A total of 49 stations were sampled during the present study, 47 of which were sampled for the 1974-75 prenourishment study. These stations encompass the nearshore zone, from the swash area to just beyond the second sandbar. In view of the low variability in numbers and species of animals at corresponding stations for the 9 transects, the 47 stations are believed to adequately sample the nearshore zone. However, the study did not totally address the area most likely to receive fine sediments resuspended by dredging activities, i.e., the area beyond the second sandbar at depths of 9 to 10 meters. Stations CA and CB were the only control areas at these depths. Optimal sampling strategy would have required control stations placed in close proximity to the borrow sites. Unfortunately, the borrow sites were not selected prior to Saloman's (1976) study.

(e) Four replicates were analyzed from each station. Species saturation curves (Gleason, 1922; Holme, 1953) were constructed for 5 stations for 12 replicates by Saloman (1976). Based on those curves it was determined that four cores adquately sampled the fauna of the study area. Species area curves were constructed for the present study for transect 5, stations 1-5, stations CA and CB, and borrow sites B1 and B2. These curves are presented in Figures D1 to D5. Each curve is the average of two randomly chosen combinations of replicate order. Only one-third (6) of the plots indicate adequate replication (criterion: increase between replicates 3 and 4 less than or equal to 10 percent). An additional replicate sample at each station would probably have resolved this problem. The four replicates analyzed give a total surface sampling area of 0.064 square meters. For most benthic studies, 0.1 square meter is considered a sufficient sample size (Holme and McIntyre, 1971). However, based on Saloman's (1976) species saturation curves and those generated for this study, these data have been determined to be adequate for comparative purposes.

(f) To determine variations due to seasonal influences, samples were collected for two seasons, November-December 1979 and May 1980. Significant differences were found in all of the faunal parameters as well as species composition between sampling periods. Saloman (1976) also revealed pronounced seasonal fluctuations. Physical parameters such as temperature and wave intensity show pronounced seasonal variation within the study area and undoubtedly influence infaunal community characteristics within the nearshore zone. The two sampling periods of this study do not adequately address temporal variations. However, in conjunction with Saloman's (1976) data (four seasonal samplings) the importance of seasonal variation was assessed.

(g) To make valid comparisons of studies conducted at different times or places, the methods used should be identical, where practical, or yield analogous results. All the sampling and processing methods used for this study were identical to those used by Saloman with the following exceptions:

(1) A 5.08-centimeter PVC core was used to obtain sediment samples instead of 8-ounce (227 grams) jars.

(2) Percent organic carbon and percent carbonate present in the sediment samples were determined by combustion (500° Celsius for organic carbon and 1,000° Celsius for carbonate). Saloman (1976) used a Leco 750-100 90-second carbon analyzer. These methods have been shown to yield comparable results (Carver, 1971).

(h) Taxonomic procedures followed standard literature keys and expert confirmations. Additionally, a reference collection of species collected during the 1974-75 study was provided for comparative purposes.

(i) Sediment samples have been analyzed by standard geological methods, tabulated and summarized for each station. Analytical methods and numerical indices were chosen on the basis of their widespread use in scientific literature and their ability to provide data summaries.

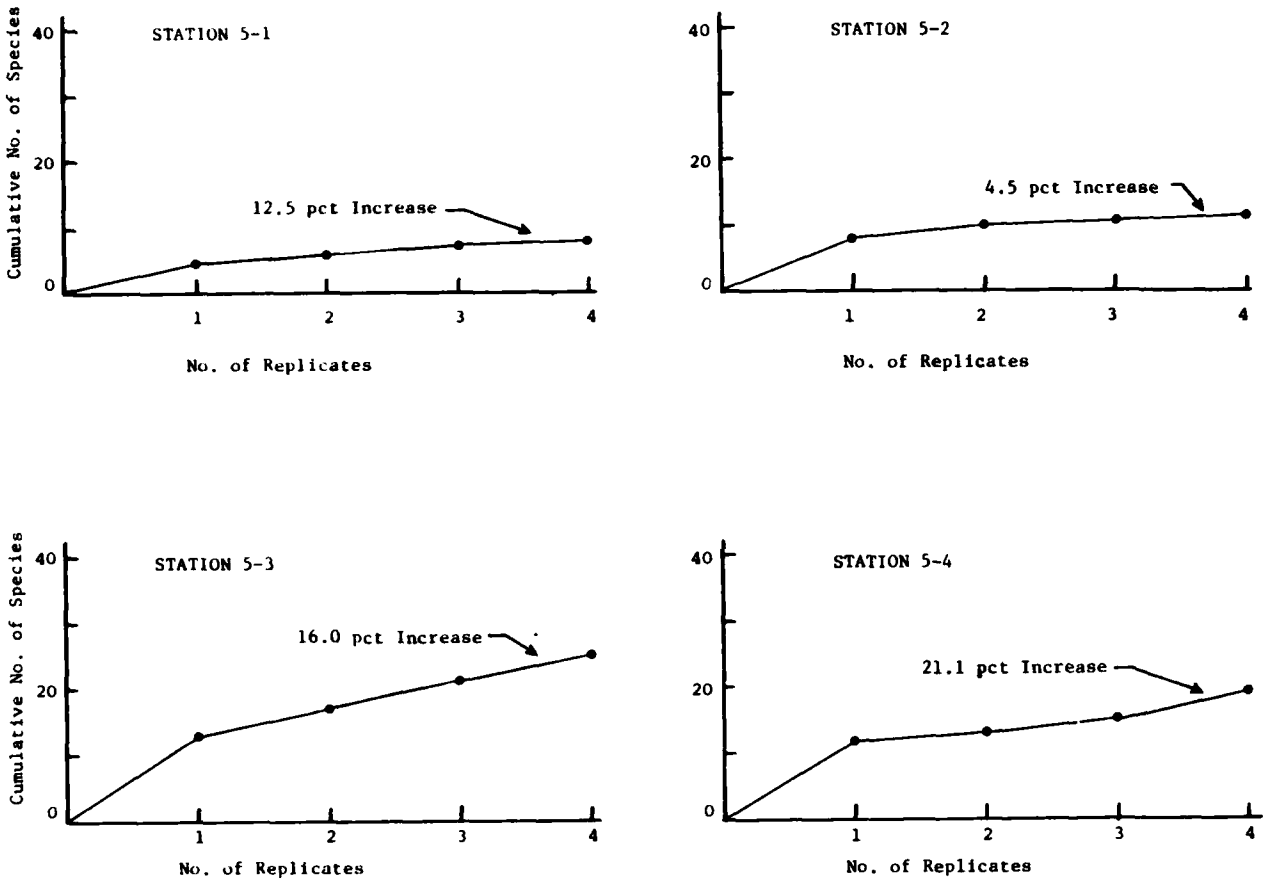
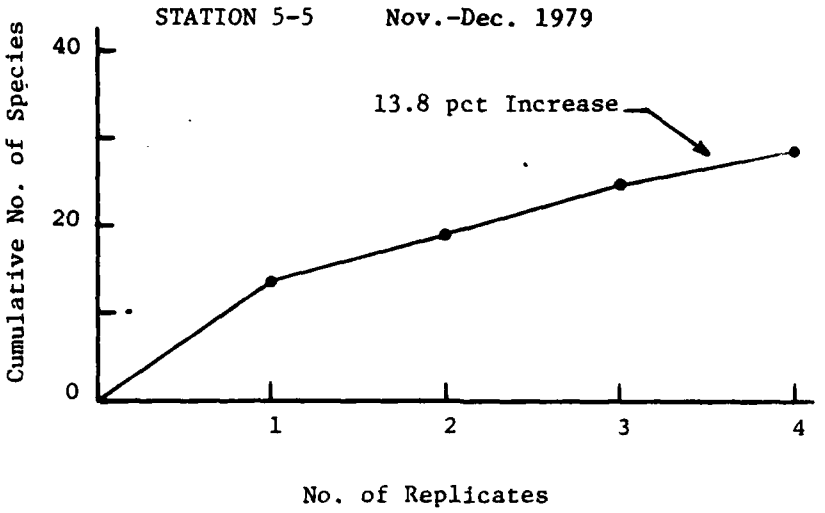


Figure D-1. Species area curves for stations 1 to 4 of transect 5 for the November-December 1979 sampling.



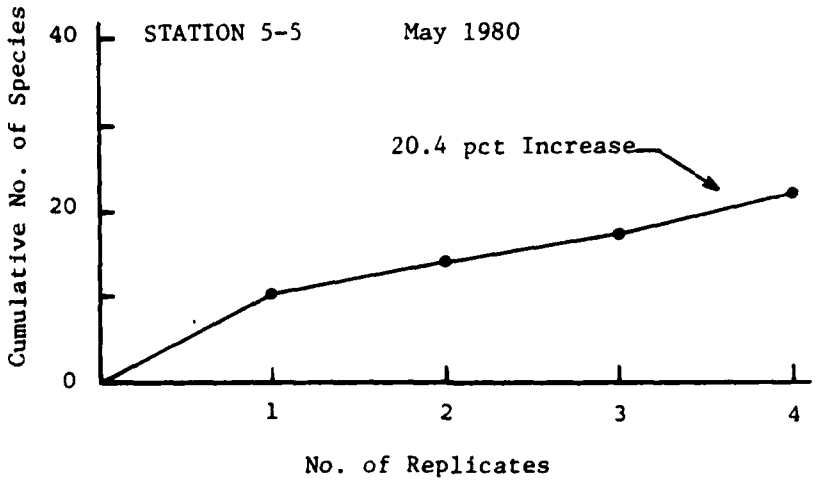


Figure D-2. Species area curves for station 5 of transect 5 for the November-December 1979 and May 1980 samplings.

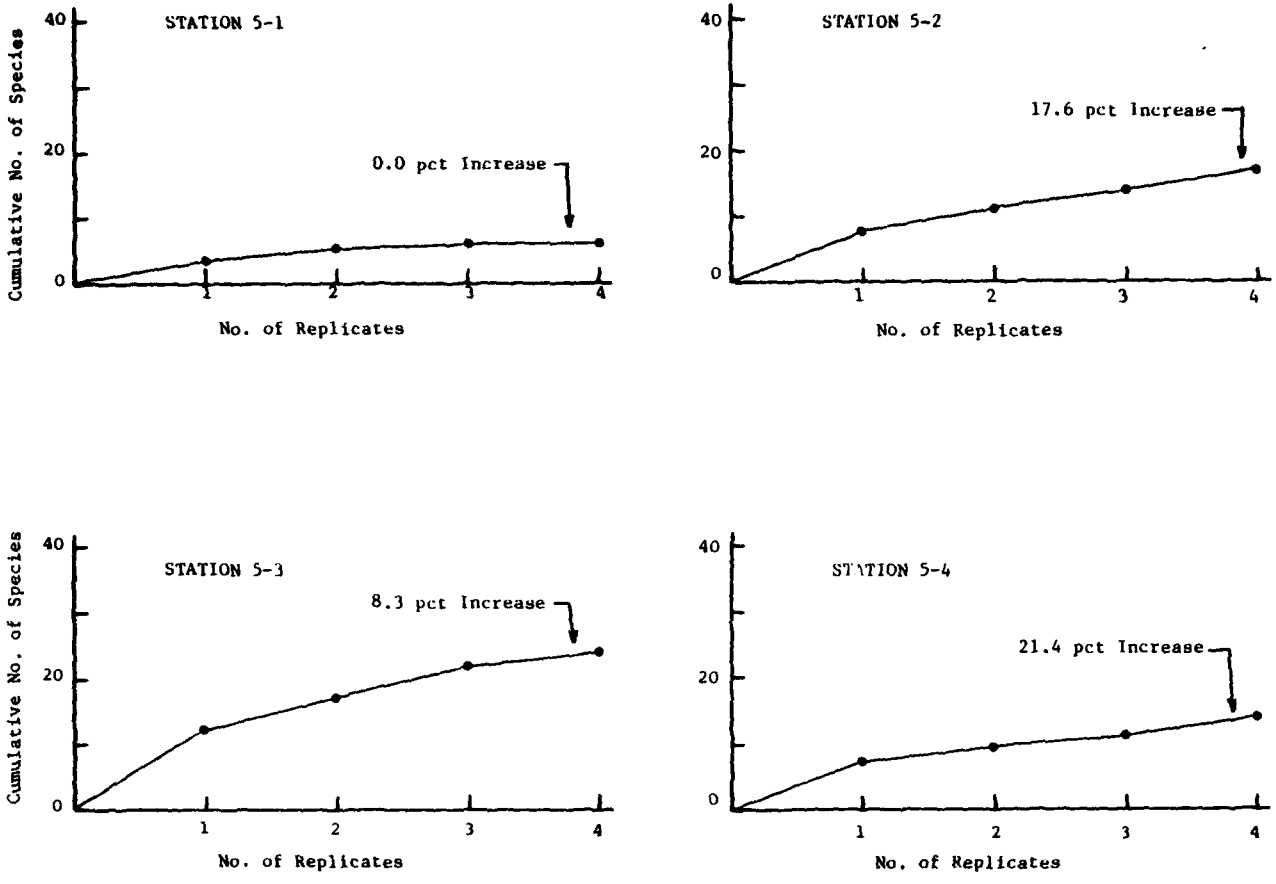


Figure D-3. Species area curves for stations 1 to 4 of transect 5 for May 1980.

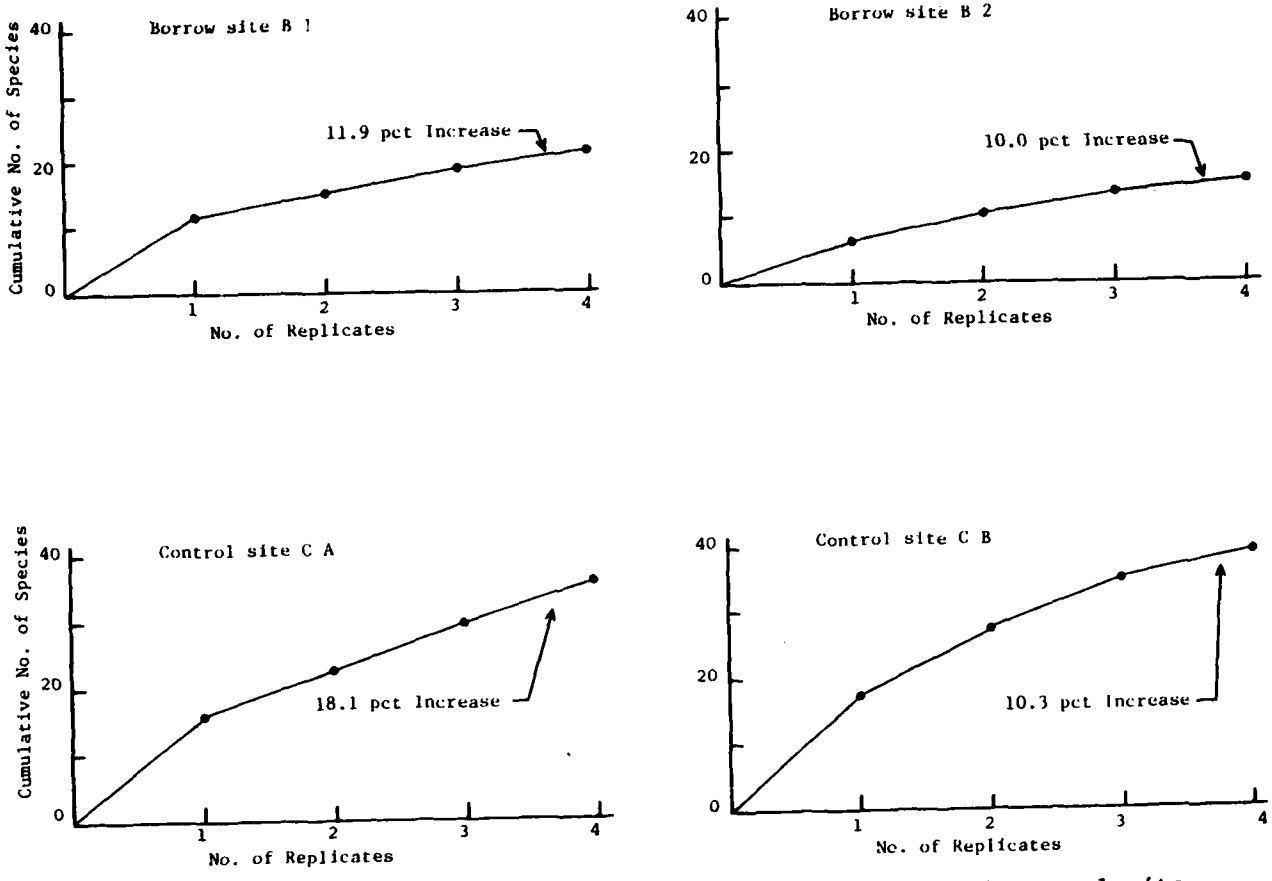


Figure D-4. Species area curves for bottom sites B1 and B2 and control sites CA and CB for the November-December 1979 sampling.

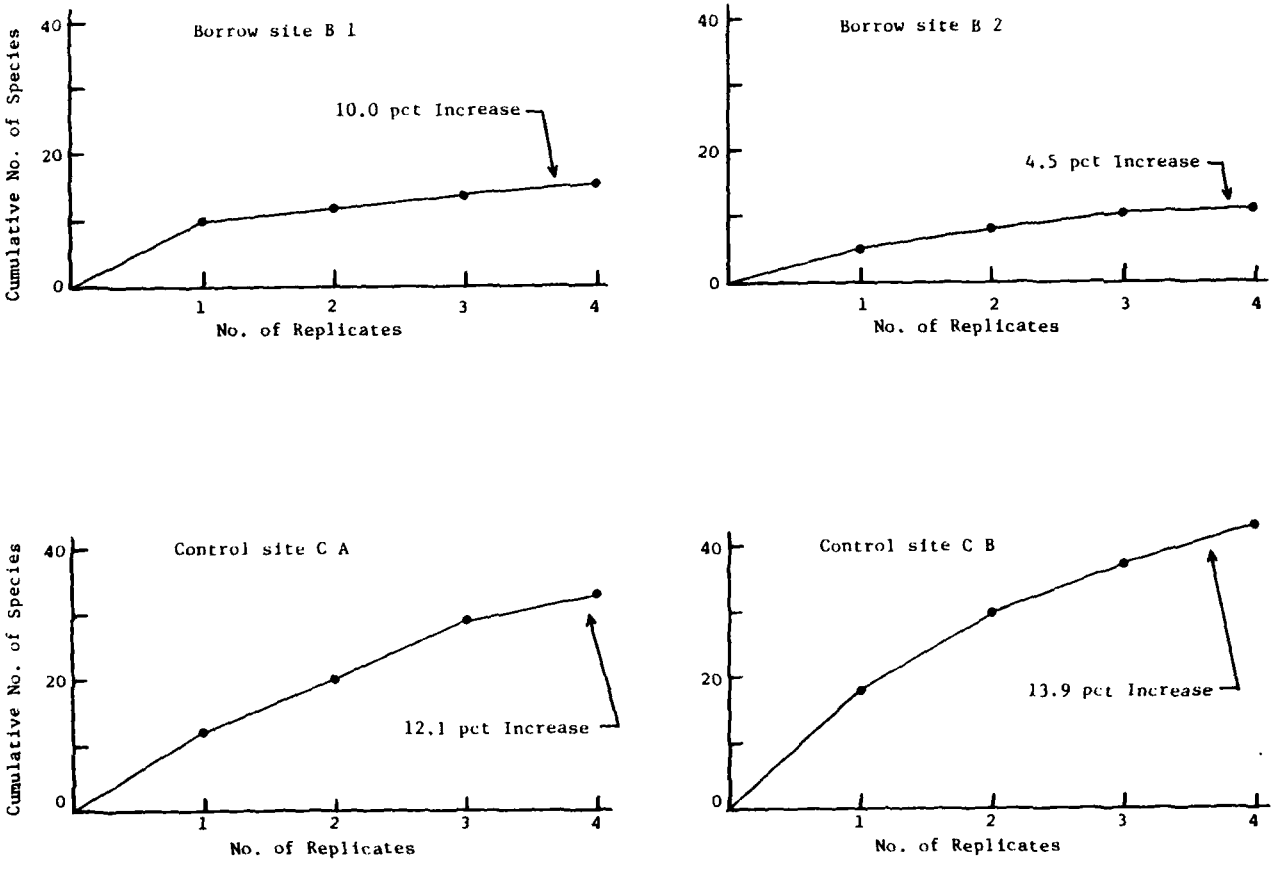


Figure D-5. Species area curves for borrow sites B1 and B2 and control sites CA and CB for May 1980.

Culter, J.K.

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"Literature cited" : pp. 52-57.

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